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Heating Piping & Air Conditioning

DESIGN
INSTALLATION
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OCTOBER ★ 1946

INDUSTRIAL
COMMERCIAL
INSTITUTIONAL AND
PUBLIC BUILDINGS

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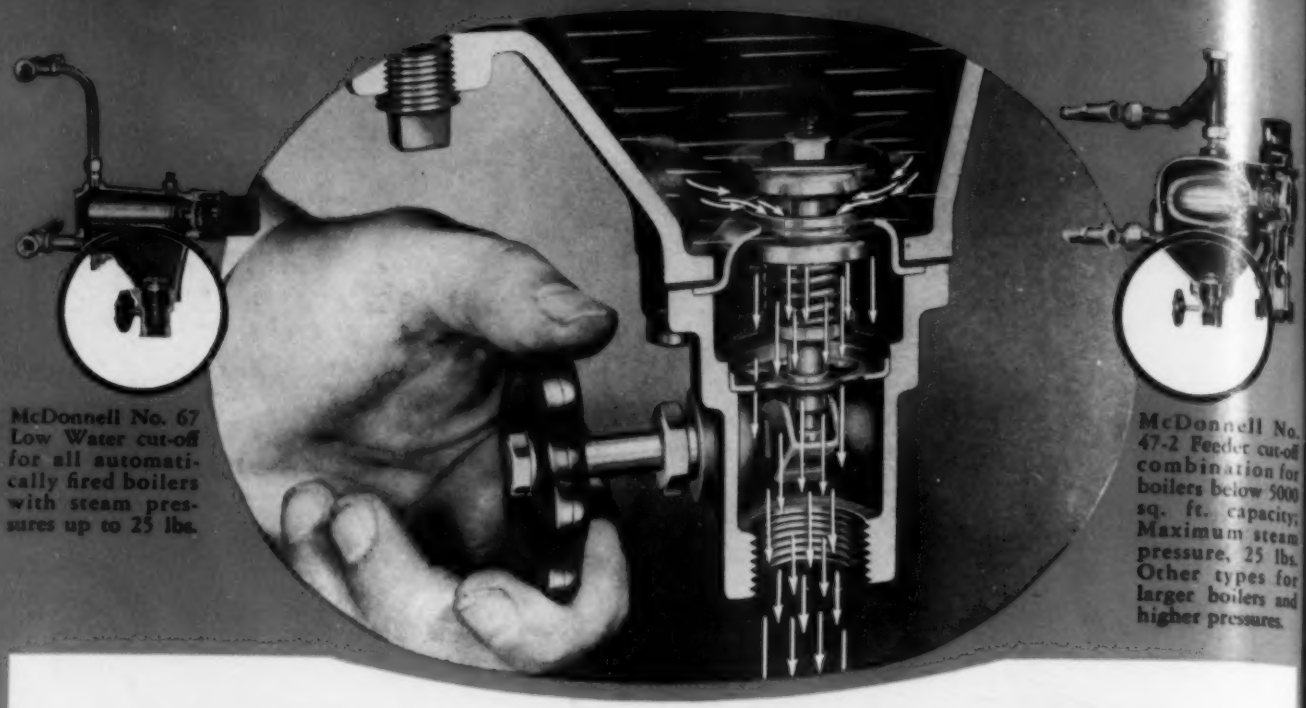
Most of the alloy steels can be joined by various welding processes with excellent results—see page 67



McDonnell No. 67 Low Water cut-off for all automatically fired boilers with steam pressures up to 25 lbs.

McDonnell No. 47-2 Feeder cut-off combination for boilers below 5000 sq. ft. capacity; Maximum steam pressure, 25 lbs. Other types for larger boilers and higher pressures.

There's a world of difference in blow-off valves

There are two kinds of equipment: The kind that is just turned out, and the kind that is *thought* out—designed down to the last detail to do its job right. We can cite a lot of features that put McDonnell Boiler Feeders and Low Water Cut-offs in the thought-out class, but probably none is more convincing than the blow-off valve illustrated above.

In ordinary feeders and cut-offs the blow-off valve is just a standard, common-garden type. At one time ours was that kind, too, but we have a way of watching our product on the job, and it didn't take long to see that a special type of valve was needed.

We found that a standard valve fails to accomplish two functions which a blow-off valve should perform. In the first place, a conventional valve isn't very effective in ridding the float chamber of mud and silt. In the second place, it is practically worthless in the still more important, though less apparent function of a blow-off valve—draining the float chamber so that the action of the feeder or cut-off switch can be tested.

Obviously, to carry out these two vital functions properly, a quick-acting valve is needed with a large, wide-open, unobstructed passage. When we found that these qualities were not provided by any standard valve, we decided to make our own valve.

You see its construction above. When the handle is given a half turn its disc lifts high above the seat, loosening any sediment above it and opening an orifice that is actually larger than the valve's outlet. The big straight-through passage does a real job of sluicing out accumulations. Even more important than this, the big capacity of the valve quickly drops the water level in the float bowl, because water can not enter the bowl as rapidly through the half-inch equalizing pipe from the boiler as it flows out of the big 1-inch area orifice of the blow-off valve. This means quick, easy testing of the feed valve and cut-off switch. Regular testing of feeders and cut-offs is always advisable. In fact it is often made compulsory by insurance regulations and city ordinances. With this blow-off valve you or the owner or inspector can make an absolutely accurate test with the twist of a wrist.

Yes, there's a world of difference in the blow-off valve used in McDonnell controls—and there is a world of difference in many other things that put them in a class all their own.

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Boiler Water Level Controls

THE EDITOR'S PAGES

GETTING CPA APPROVAL ON NON-HOUSING WORK

The Civilian Production Administration gave builders detailed instructions September 6 on the preparation of applications for authorization to do non-housing construction or repair work restricted under the veterans housing program order No. 1.

The instructions are contained in direction 2 to order VHP-1 and explain how to fill out form CPA-4423, which must be filed with CPA in applying for construction authorization. The instructions follow:

a) Applications for authorization under veterans' housing program order 1 to do non-housing construction or repair work restricted by that order are filed on form CPA-4423. This form requires the applicant to state in item 4c the estimated cost of processing equipment to be used in the proposed project, excluding reused equipment. In item 5, the applicant is required to state the estimated cost of the project, not including the cost of the land, existing structures and architects' and engineers' fees. The figure in item 5 is to be broken down into two items, the cost of fixtures and building service (mechanical) equipment and the cost of structures, excluding the cost of fixtures and mechanical equipment.

b) The applicant should enter under item 4c the total cost or value of all of the kinds of equipment and machinery listed under paragraph (b) (2) of supplement 1, except used equipment. The figure entered in item 4c should also include the total cost or value of the kinds of items listed under paragraph (b) (3) of supplement 1, (except when they are fixtures) excluding the cost or value of used equipment. These paragraphs list various kinds of processing equipment and various kinds of servicing equipment.

c) The applicant should enter as the "cost of fixtures and building service (mechanical) equipment" in item 5 the cost or value of all of the items of the kinds described and listed in paragraph (b) (1) of supplement 1 to VHP-1. This paragraph lists various kinds of fixtures and plumbing, heating, lighting, and ventilating equipment. He should also enter the cost or value of items listed in paragraph (b) (3) when fixtures. The cost of installation of fixtures and items of equipment should be included along with the cost of the fixtures and the equipment. It is not necessary to include the cost of used fixtures and equipment (or the cost of installation) which have been severed from the structure owned by the builder (the owner or occupant of the building) and are to be used without change of ownership.

d) The applicant should include as the "cost of structures" in item 5 the cost of the building or buildings, excluding the cost of processing equipment and the cost of fixtures and mechanical equipment. The applicant need not include in this figure the cost or value of materials and labor which do not constitute part of the cost of the construction job under paragraph (g) of supplement 3 to VHP-1. Paragraph (g) (2) of that supplement lists numerous specific items which may be excluded from the cost of a job under VHP-1.

COUNTY NEEDS MEN FOR AIR POLLUTION STUDY

Employment opportunities for properly qualified personnel are announced by the Los Angeles county civil service commission in a countywide program investigating sources of air pollution, recommending corrective measures, and enforcing control ordinances. One vacancy to be filled is that of assistant director of air pollution control with a salary of $550 a month. Other vacancies are those of air pollution engineers (temporary) with a salary of $375 to $464 and air pollution inspectors with a salary of $300.

Requests for application blanks and detailed information should be addressed to the Los Angeles County Civil Service Commission, Room 102, Hall of Records, Los Angeles 12, Calif.

STEAMFITTERS, PLUMBERS VOTE TO UNITE AS TRADE CRAFT

Approval of a resolution calling for unification of steamfitters and plumbers as one trade craft was voted last month by delegates to the convention of the United Association of Journeymen Plumbers and Steam Fitters of the United States and Canada.

Said to be one of the most important decisions of the association in its 57 year history, the resolution provides for changing the organization's name to the United Association of Journeymen and Apprentices of the Plumbing and Pipe Fitting Industry of the United States and Canada.

SIMPLIFIES HEATING, PIPING MAINTENANCE

An electric high-lift truck can be used to simplify the installation and maintenance of overhead plant equipment such as unit heaters and conditioners, piping, sprinkler systems, lighting circuits, skylights, etc., says the Yale & Towne Mfg. Co.

For example, the maintenance man in the picture can move from heater to heater conveniently and speedily. Painting a pipe line or installing wiring, the truck moving along as the job progresses, would be other uses.

The maintenance man can move speedily from heater to heater by using an electric high-lift truck as shown here

THE EDITOR'S PAGES

SEES SAVINGS WITH 12 MONTH VACATION SCHEDULE

Business and industry can effect a large saving, "undoubtedly running into millions of dollars annually," by adopting the year 'round schedule for employees, and at the same time can maintain better employee relations, according to William B. Henderson, executive vice-president of the Air Conditioning and Refrigerating Machinery Association, 717 Southern Bldg., Washington, D. C.

Referring to a recent survey conducted by the National Industrial Conference Board, which disclosed that the old Memorial Day to Labor Day vacation season is being extended to embrace all 12 months, Mr. Henderson said the trend undoubtedly has had its beginning due to the more extensive use of air conditioning by factories, retail stores, offices, and other commercial establishments.

"The advantage of year-around vacations," he said, "is that business can operate at the same tempo throughout the entire year. There are 26 two-week vacation periods in the 12 months. By adopting the year-around schedule, a business of 100 employees would have about four absent at all times, instead of 15 or 20 during the summer months. By taking on four additional employees, this business would find vacations no longer disrupting. The effect would be to stimulate employment while producing greater business efficiency.

"Many businesses find their staffs so depleted during the three summer months that routines are destroyed, and service to customers suffers. Production is curtailed in industrial plants. The vacation season has been particularly bad for some small businesses. During the period when it has been difficult to obtain temporary help, many businesses have closed down entirely for two weeks in the summer, in order that all employees might take their vacations at the same time.

"Vacations have been squeezed into the three months because of the weather. Many people would like to vary their vacation periods each year, and the year-around schedule would find many employee supporters. But the heat and business custom have been obstacles. Heat and humidity cause fatigue and loss of efficiency. This has been overcome for employees where air conditioning has been introduced. The improvement of working conditions was demonstrated in many war plants, including plants in the south. In addition, as air conditioning is introduced in retail establishments the old time summer trade slump tends to disappear. As summer shopping increases, sales staffs reduced by vacation exodus will no longer be adequate to handle the trade, making a year-around vacation program imperative.

"With a 12 month vacation schedule, the costly summer shutdowns and slowdowns can be avoided and in the aggregate business would save a large sum. Winter vacation business would be stimulated, transportation congestion would tend to level off, and new vacation areas could be opened in sections which at present have no special summer appeal. Undoubtedly this year-around vacation trend will be accelerated, and the results will be beneficial both to business and employees."

DR. A. R. STEVENSON, JR., NOTED ENGINEER, DIES

Dr. A. R. Stevenson, Jr., staff assistant to General Electric's vice-president in charge of engineering policy, died suddenly August 18. He was 53 years old.

Dr. Stevenson played a prominent part in establishing G. E.'s advanced course in engineering, and helped create the air conditioning department.

He was a fellow of the American Society of Mechanical Engineers and served on the society's executive committee; a past president of the American Society of Refrigeration Engineers; a fellow of the American Institute of Electrical Engineers; and a past president of the Private Flyers Club.

ADVICE TO DRINKERS DEPARTMENT

Although most workers will not knowingly drink an organic solvent, protection from this possible hazard should be a plank in industrial safety platforms, says the Safety Research Institute. For when solvents are taken internally, they may cause permanent damage to tissues and organs and, in severe cases, death may result.

Solvents may be swallowed by intent or by accident. The story is told of a worker who heard someone describe a certain solvent as being "toxic." The term sounded pleasantly similar to "intoxicating" whereupon the man decided he would sample the liquid —which he did with fatal results. If a man is informed that swallowing chemicals is dangerous and that solvents are no exception to this rule, it is not likely that he will deliberately violate it.

Accidents, however, can arise from a number of circumstances. A case in point is that of a carpenter who was quietly drinking liquor in the dark. When he reached for the liquor bottle, after having set it down on a table, his fingers closed about a bottle of solvent placed on the same table. He drank some and died in about 10 days. In another instance, a man came into a shop to see a pail of liquid, which he thought was water, standing open on a bench. He swallowed a dipperful before he realized it tasted peculiar. Fortunately, he immediately vomited and was none the worse.

All vessels or containers of solvent should be clearly marked and they should be kept out of reach of visitors and workers from other departments who may be passing through rooms in which solvent operations are performed.

A doctor should be called at once if anyone swallows a solvent, even if no symptoms of discomfort or poisoning are immediately evident. Solvents may have a delayed effect. First aid measures are limited to inducing vomiting, so as to remove the solvent from the body. Some common emetics are mustard water, lukewarm salty water, and soapy water. While waiting for the arrival of the doctor, the accident victim should lie quiet in a well ventilated atmosphere.

Heating Piping & Air Conditioning

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Published monthly by the Keeney Publishing Co., 6 North Michigan Avenue, Chicago 2, Illinois. Telephone: State 6916. Subscriptions: U. S. and possessions, Canada, Mexico, Central America, South America, $2.00 per year; other, $4.00. Current copies, U. S. and possessions, 25c each, back copies, 50c each. January 1946 issue, $1.00 per copy. Member of the Audit Bureau of Circulations and of the Associated Business Papers, Inc.

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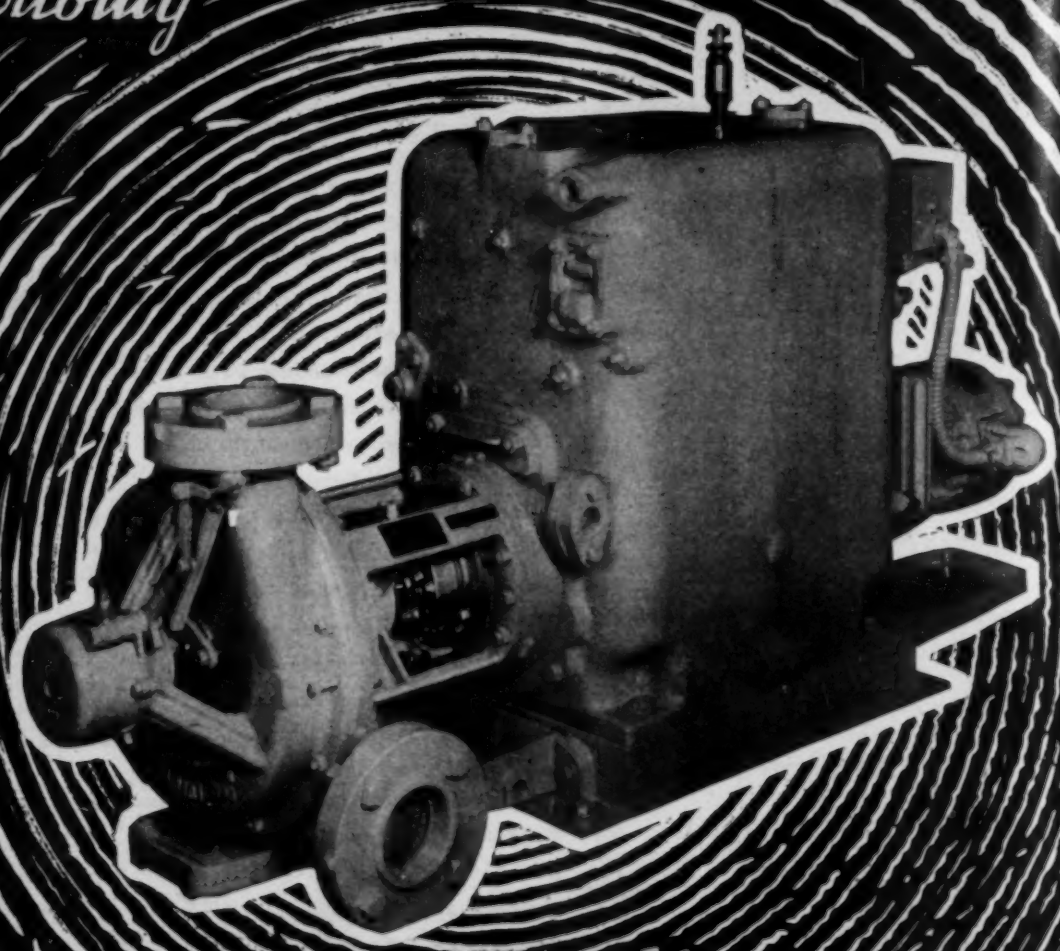
Centralized Heating Economy



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WELDING Alloy Steel PIPING

Eric R. Seabloom Discusses Techniques for Joining One-Half to Ten Per Cent Chromium-Molybdenum Alloys...Other Articles to Come

WELDING is being employed to a great extent in the fabrication and erection of piping for many types of service. Most of this has been with the plain carbon and simple low alloy steels. As pressures and temperatures continue to increase and with the anticipated growth of process industries, more alloy steels will, no doubt, be employed in the near future. The groups of alloy steels that will, most likely, find greater usage are the chromium-molybdenum, straight chromium, and the chromium-nickel varieties, since they display improved high temperature stability, oxidation and corrosion resistance.

Most of these alloy steels, while not being as weldable as the plain carbon steels, can be joined by various welding processes with excellent results, but some require special techniques involving preheating, stress relieving, or heat treatment.

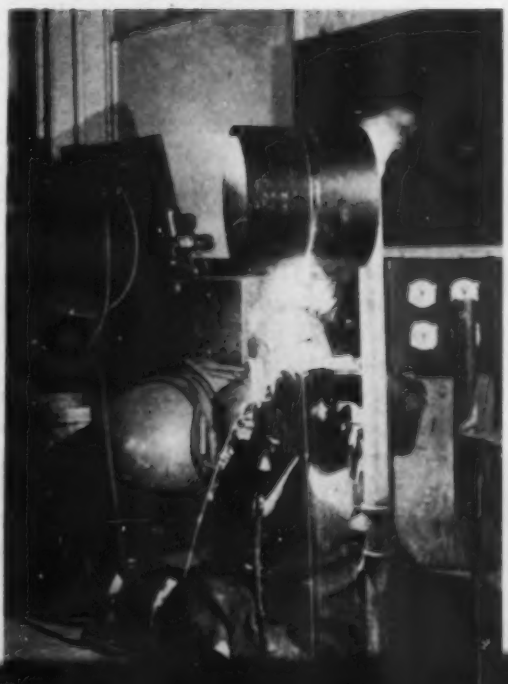
Chromium-Molybdenum Steels

The chromium steels shown in the accompanying table have small additions of molybdenum to impart creep strength and resistance to temper embrittlement and are, therefore, used extensively on high temperature service.

The lower alloy grades, such as ½ per cent, 1 per cent, and—to a minor degree—2 per cent chromium are being employed in steam power plants operating at 900 to 1000 F to offset the danger of graphitization in the weld contact zones, that has been experienced with some of the carbon-molybdenum steels. Alloy steels containing from 2 to 10 per cent chromium are used extensively in oil refineries at high temperatures to obtain oxidation and corrosion resistance, the chromium content selected depending upon the temperature and the corrosive environment.

Characteristics Pertinent to Weldability

The chromium-molybdenum alloy steels are air hardening— that is, the welds and adjacent parent metals harden when air cooled from the welding heat. They are air hardening because of suppressed transformations that occur upon cooling from high temperatures which is the reason some of these steels are apt to crack when welded. The tendency toward air hardening or suppressed transformation is dependent on the chromium and carbon contents. The degree of hardening and suppressed transformation is not so marked in the ½ per cent to 2 per cent chro-



The usual positions of welding as defined by the American Welding Society and various code nomenclature. These illustrations show an operator making his qualifying tests on butt welds. Top to bottom—Type 1B weld, horizontal rolled position, flat weld. Type 3B weld, vertical fixed position, horizontal weld. Type 4B weld, horizontal fixed position, vertical and overhead welds

mium types with low carbon content, but with higher carbon it becomes more pronounced. The 4 to 10 per cent chromium grades display the same characteristics regardless of the carbon content, although higher carbon aggravates the condition.

Suppressed transformations are determined by a dilatometer which records the expansion and contraction that occurs in metals upon heating and cooling. From the accompanying heating and cooling curves on plain carbon, carbon-molybdenum and 4-6 per cent chrome, ½ per cent molybdenum steels, it will be observed that upon heating, these steels expand according to a slope of approximately a straight line or a smooth curve. Then a point is reached at which they contract and continue to contract over a considerable range of temperatures. Beyond that range each steel again expands according to a slope of nearly a straight line. The temperature range in which the above mentioned contraction takes place is known as the transformation range. In it, on heating, steel changes from its low temperature (ferritic) to high temperature (austenitic) state.

Upon cooling, a reverse effect is obtained. In the case of plain carbon steel, the transformation from the austenitic to ferritic state is well defined at the temperature range of 1400 to 1150 F. In carbon-molybdenum steel, the transformation on cooling is not quite as well defined as in carbon steel. The major part occurs at about the same temperature range as in the plain carbon steel. Part of it, however, is suppressed to about 980 F, indicating what is known as the phenomenon of "split transformation." Nevertheless, in both of these steels, major contractions associated with the transformation upon cooling occurs at temperatures sufficiently high to give the metal enough plasticity to readjust itself internally, thus relieving most of the internal strain and eliminating the potential danger of cracking. Consequently, no difficulty is encountered in welding steels of these two types.

Chromium-Molybdenum Steels For High Temperature Service

Type of Alloy	Carbon Content	Chromium Range	Molybdenum Range
½ Cr ½ Mo	0.20 Max.	0.40 to 0.60	0.45 to 0.65
1 Cr ½ Mo	0.15 Max.	0.80 to 1.10	0.45 to 0.65
2 Cr ½ Mo	0.15 Max.	1.75 to 2.25	0.45 to 0.65
5 Cr ½ Mo	0.15 Max.	4.00 to 6.00	0.45 to 0.65
7 Cr ½ Mo	0.15 Max.	6.00 to 8.00	0.45 to 0.65
9 Cr 1½ Mo	0.15 Max.	8.00 to 10.00	1.25 to 1.75

In the case of 4-6 per cent chrome, ½ per cent molybdenum steel, only a very weak transformation occurs at 1250 F. The major part is suppressed to about 700-400 F. The split and suppressed transformations are characteristic of chromium alloy steels and are accounted for by their thermal sluggishness. The important thing about suppressed transformations is that they occur at temperatures when the metal is no longer plastic, thus creating internal strains, which unless properly taken care of by suitable techniques may result in cracking. It will be noted that the presence of internal strain in the 4-6 per cent chrome, ½ per cent molybdenum steel is indicated by the fact that the specimen did not return to its original length, being somewhat shorter than it was before the heating-cooling cycle. It is natural to expect that steels of this type will show definite tendencies to crack during or after welding operations unless suitable precautions are taken. When proper procedures of preheating, welding, stress relieving, or heat treatment are followed, such steels can also be welded without difficulty and the resultant welds will be strong, sound and ductile, meeting the requirements of the ASME Boiler Code and the ASA Code for Pressure Piping on procedure and operator qualification tests. Typical weld bend test bars in 1.00 per cent chromium—½ per cent molybdenum steel that are required for qualification are shown in one of the illustrations.

MOST OF THE alloy steels—such as the chromium-molybdenum, straight chromium, and the chromium-nickel varieties—while not being as weldable as the plain carbon steels, can be joined by various welding processes with excellent results. Some, however, require special techniques involving preheating, stress relieving, or heat treatment. . . . Mr. Seabloom, supervising engineer of the Crane Co. research laboratories, writes this month on the ½ to 10 per cent chromium-molybdenum alloys, and later articles will cover the 10 to 30 per cent straight chromium steels and the chromium-nickel austenitic stainless varieties. This material is reproduced from his series of articles in Valve World, published by Crane.

Joining Processes Applicable Gas Welding

The lower chromium ranges of these steels can be successfully welded with the oxy-acetylene flame without many precautionary measures, except that welding rods giving deposited weld metal analysis equivalent to the parent metals may not be available for all types of steel. Also the flame adjustment is important. A neutral flame is recommended with a slightly lower heat than normally employed for the plain carbon steels. An oxidizing flame should be avoided since chromium oxidizes readily and will be burned out. Proper fusion will also be difficult to obtain with an oxidizing flame. A reducing or excess acetylene flame will increase the carbon content in the weld metal, thus adding to the air hardening properties. Special fluxes have been developed for gas welding of chromium steels, which are able to dissolve the chromium oxides and aid in producing satisfactory welds, especially with the higher chromium types.

Preheating of the adjacent areas to be welded, at 400 F minimum, is essential to prevent cracking, but since this is virtually automatically accomplished by the oxy-acetylene process, no special preparations are required. The welds should be cooled slowly from the welding heat and stress relieved or heat treated after welding. Heat treatment is covered in a later paragraph since this is the same for any process of welding.

Welding grooves recommended are the single vee butt type and fillet or socket joints. Socket type fittings may not be available in all grades of these alloys. Welds can be made in all positions.

Brazing or soldering is not generally employed, since these alloys are primarily used at elevated temperatures and the joining materials do not possess the high temperature physical properties of the parent metals.

Atomic Hydrogen Welding

Although not used to any great extent, chromium steels can be

welded by the atomic hydrogen process. The hydrogen atmosphere surrounding the arc stream aids in reducing the oxides and no carbon pickup is encountered, since there is no carbon present in the flame. In fact, a reduction in carbon content is generally experienced. Sound welds having good ductility after heat treatment can be made on these alloys, although the process lends itself best to the lighter wall thickness of pipe. Single vee butt joints and fillet or socket joints are recommended, but welding should preferably be done in the downhand position. Preheating to about 400 F is necessary, which is usually adequately supplied from the heat of the arc and the hydrogen flame. Stress relieving or heat treatment is covered in a later paragraph.

Metallic Arc Welding

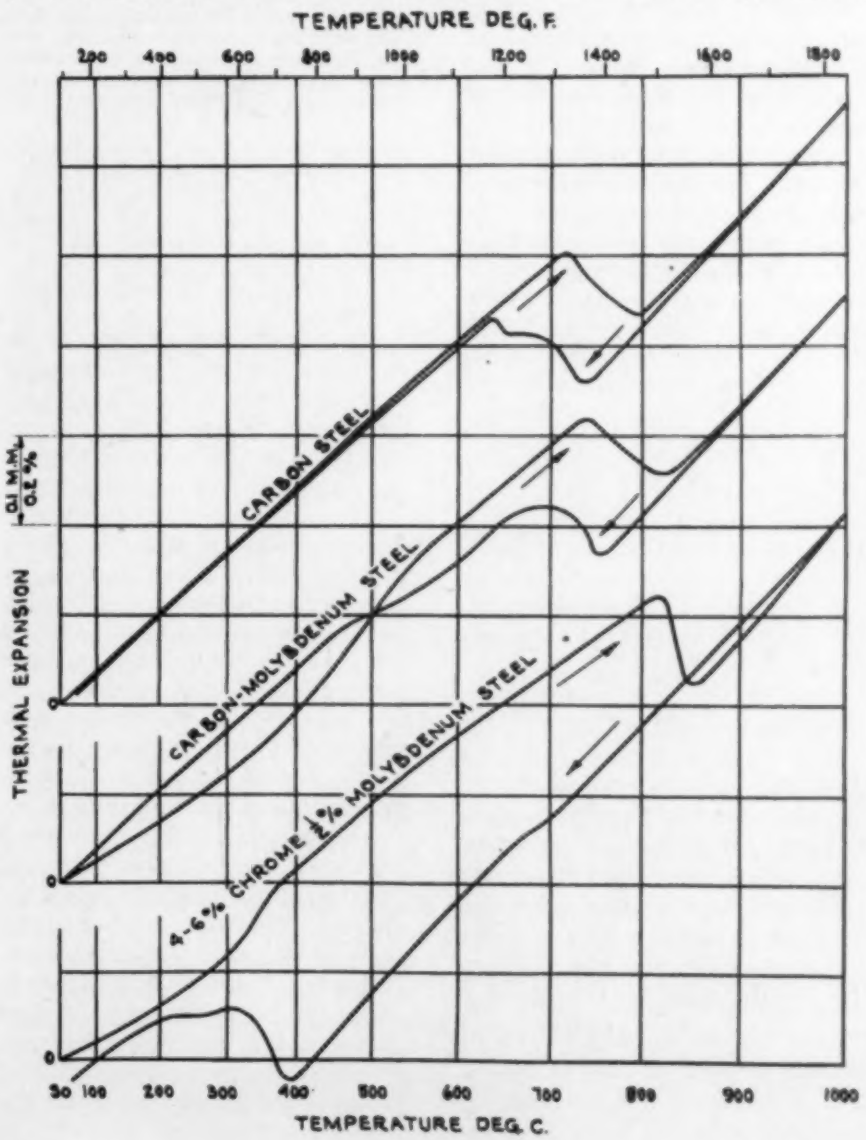
Metallic arc welding is, no doubt, the preferred method of welding for all of the chromium-molybdenum alloys, as most specifications by engineering firms and users of piping equipment specify arc welding for both power and oil refinery construction. Coated electrodes are available for most of the alloys and generally give deposited weld metal analyses to match those of the parent pipe materials. Some loss in chromium occurs in the arc and in the majority of electrodes this is compensated for in the core wire analysis and electrode coating. The electrode coatings usually contain fluxing agents to dissolve the chromium oxides and the control of carbon content in the weld deposit is obtained through the use of low carbon core wire and avoiding carbonaceous materials in the electrode coatings.

The types of welding grooves recommended for arc welding are the single vee butt joints without or with backing rings, and fillet or socket joints. Electrode sizes used are generally smaller than those employed on the plain carbon steels and seldom exceed 3/16 in. in diameter. Welds can generally be made in all positions.

Occasionally it is necessary to join chromium - molybdenum steels to dissimilar metals, such as carbon and carbon-molybdenum steels or to chromium-nickel stainless steels. When welding chromium-molybdenum to carbon steel, mild carbon steel electrodes conforming to AWS—ASTM specification A-233 grade E-6010 or chromium-molybdenum electrodes matching the alloy can be used. However, if the carbon steel pipe is grade "B" material in which the carbon content may be above 0.20 per cent carbon, then it is advisable to avoid chromium molybdenum electrodes, as drastic air hardening occurs when the carbon exceeds 0.25 per cent with chromium contents above 1.00 per cent. Chromium-molybdenum steel can be welded to carbon-molybdenum employing either carbon-molybdenum grade E-7010 electrodes or chromium-molybdenum electrodes of similar analysis to that of the base metal, as the carbon content on carbon molybdenum pipe is generally not too high to cause trouble. For welding the chromium-molybdenum alloy to chromium-nickel stainless steels it is recommended that 25-12 or 25-20 chromium-nickel electrodes be employed.

Sometimes the conditions are such that stress relieving or heat treatment on chromium-molybdenum steels after welding is not practical; then chromium-nickel stainless electrodes are employed, but caution should be exercised in their application. The fusion zones and heat affected areas will be brittle even though the welds are ductile, especially with the higher chromium contents. The differences in coefficient of thermal expansion may cause high thermal

Dilatometer curves on carbon, carbon-molybdenum, and 4-6 per cent chromium—½ per cent molybdenum steel. Note the differences in transformations upon cooling



stresses and stress corrosion possibly will be encountered.

Preheating

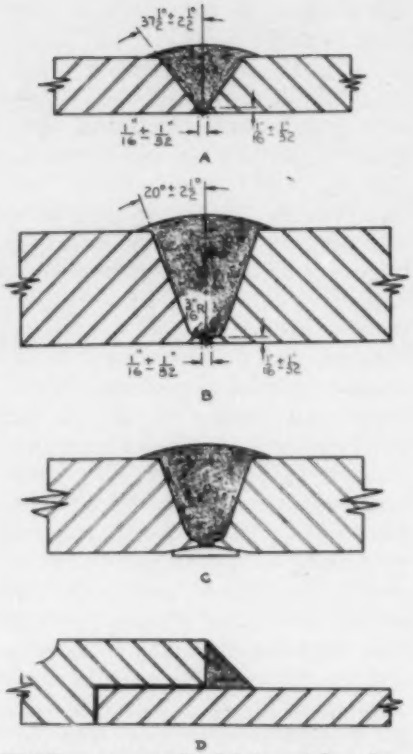
In arc welding, preheating is a separate operation, whereas in gas and atomic hydrogen welding it is accomplished by the process itself. Preheating is a very necessary requisite in welding of the air hardening alloys since it prevents a rapid quench on the weld metal as it is being deposited, retards the cooling rate, and prevents cracking. Preheating can be accomplished in several ways, but the minimum prescribed temperature is about 400 F, although some authorities recommend 300 F, while others specify 800 F and even higher. It is felt that 400 F is a good practical temperature as satisfactory welds are being produced under such conditions without too much discomfort to the welding operators.

Preheating can be done by oxyacetylene torches, suitable gas burners, electric induction coils, or electric resistance coils. Heating should be gradual and uniform with the temperature maintained during the welding operation. The temperature can be checked by means of heat indicating pills or sticks, surface pyrometers, or thermocouples.

Heat Treatments

Heat treatments of weldments in these alloys consist of normalize and draw, anneal or stress relief, depending upon where the fabrication is made (that is, shop or field), furnace equipment, and type of alloy involved. If shop fabricated, full furnace heat treatments are generally preferred, but this is not always feasible, especially where welding end valves are welded into a piping assembly. In such a case, the valve operating mechanism may become damaged and local stress relieving is resorted to. Also in field erection of piping, the only method of heat treatment is a local stress relief.

Normalize and draw consists of normalizing at 1600 to 1800 F followed by air cooling. Drawing should be done at 1250 to 1425 F, the temperature in both cases depending upon the alloy involved



Welding grooves for joining piping. A—Butt weld for ¾ in. wall thickness and less. B—Butt weld for wall thickness above ¾ in. C—Butt weld with tapered backing ring. D—Fillet or socket weld

and the physical properties desired. Cooling from the draw may be in the furnace or in air. Annealing is generally done by furnace cooling after soaking at 1550 to 1650 F.

Stress relieving can either be done in a heat treating furnace or by local means, such as gas burners, clamp-on gas fired furnace, electric induction coils, or electric resistance coils. In field erection, a local means of heating is generally employed and consists of heating a circumferential band containing the weld at the center. The width of the band heated to the desired temperature should be at least twice the width of the weld and beyond this zone the temperature should diminish gradually. In the previously described treatments the heating is accomplished above the critical or tranformation temperature, but in stress relieving the temperature must be below the critical, otherwise air hardening will occur. The temperature selected for stress relieving depends upon the chromium and carbon contents. It is generally desired to select the highest stress relieving temperature in order to obtain the maximum softening, but this is not always possible unless the characteristics of the particular steel are known. A safe range for these steels is 1300 F to 1350 F, providing good control of furnace temperature variations is maintained. If this is somewhat doubtful it is recommended that the temperature be lowered slightly or additional data on the steel obtained.

In case the weldment involves dissimilar metals it may be desirable to lower the stress relieving temperature somewhat. For example, if a 1.00 per cent chromium-molybdenum steel pipe has been welded to carbon or carbon-molybdenum piping the suggested temperature is 1225 to 1275 F. This will usually lower the hardness sufficiently in the higher alloy material and reduce scaling of the latter materials.

The temperature should be brought up slowly and held at the desired temperature for at least two hours per inch of thickness, but not less than one hour, followed by slow cooling.

Radiographic Inspection

The ASME Boiler Code only requires radiographic inspection on circumferential welded joints on pressure piping coming within the scope of the code above 16 in. nominal diameter and 1⅝ in. wall thickness for steam service and above 10 in. nominal size and 1¼ in. wall thickness for water. The ASA Code for Pressure Piping does not require any radiographic examination of welded piping. Recently, however, designing engineers are specifying radiographic inspection of welded joints in steam power piping for high pressure-temperature service, in which ½ to 2 per cent chromium-molybdenum alloys are often employed.

The radiographic inspection can be accomplished by x-rays or gamma-rays emanated from radium. Since x-ray equipment is quite bulky it is usually confined to shop work. Small capsules of radium ranging in size from 25 to 200 milligrams are employed in field inspection, although they are also used in fabricating shops when x-ray equipment is not available or when welds are located in such positions that x-ray examination becomes difficult.

What Are the Effects of Heat and Cold on the Human Body?

WE HAVE a great deal of information about the limits of human tolerance for heat and cold at sea levels. In the case of heat, a man can stay for short periods in a high dry bulb temperature, perhaps 200 F if the humidity is very low. All the heat produced in the body and heat transferred into the body by radiation and convection must then be lost by evaporation. The body can produce 6 to 12 kg of sweat a day and this can account for the loss of 3500 to 7000 cal a day if it vaporizes from the surface and does not drip. With increasing humidity there is a sharp fall in tolerance. The body of a man in all temperatures above that of the skin, about 93 F, corresponds to a wet bulb thermometer. At 92 F wet bulb, a well-conditioned man can work moderately hard without great fatigue. At 94 F or higher wet bulb, he can last only an hour or so.† A few degrees above this point he cannot lose any heat and it is all stored in his body until he develops fever that is eventually fatal.

Since the ability to lose heat in hot climates depends upon the ability to sweat profusely the water supply becomes the limiting factor. A man's body does consist of 70 per cent water but only a small portion of this can be used in an emergency. If in the desert or jungle the body weight drops 5 to 10 per cent as a result of sweating, some threatening symptoms make their appearance. By the time 11 to 20 per cent is lost the man is in danger of heat stroke which is fatal if not treated promptly. Salt as well as water is lost in the sweat and the symptoms of salt deprivation may be serious. It has been found that men who are very well conditioned to heat can get along with surprisingly small amounts of salt but there is no significant adaptation to water loss and not even thirst is an adequate guide to the large amounts of fluid needed.

The "Clo" and the "Met"

The limits of tolerance to cold are not so well defined and depend to a large extent upon activity. Recently the group of scientists studying this problem have employed the new "clo" unit to represent the amount of protection against heat loss given by clothing. One clo is the equivalent of the ordinary indoor clothing worn by most people in cool weather. It is sufficient to keep a man comfortable at average room temperature while sitting in a chair. The amount of heat produced under these conditions is called 1 "met."

It is difficult if not impossible to devise a suit for an aviator that has a clo value much greater than 4. If a man is sitting down quietly, therefore producing only 1 met, a 3 clo unit will keep him comfortable and protect his body against loss only at temperatures above 30 F. On the other hand, if he is walking and producing 3 met, this suit will protect him at —40 F. A man in a sleeping bag in a tent at 10 F needs 8 clo protection, or his body temperature will fall to dangerous levels.

There are many interesting problems presented in the study of heat loss through clothing in cold climates. We do not understand the relationship of the various factors. Water vaporizing from the skin condenses in the garment and gives back the heat of vaporization. Some of this returns to the skin but most of it is lost outwardly. After a certain point the garments take up no more moisture. The losses by convection depend upon air movement and temperature differential, and the size of the cylinder represented by the body and its parts. We know very little about the role of radiation in transferring heat through the many layers of garments and not much about radiation from the surface of the garments to the surrounding objects. Heat loss is, of course, proportional to surface which increases as we put on more garments. Convection increases with body movement. Clothing protection has sharp limits.

Athletic Records Made With a Fever

The human body temperature seldom departs from its normal average of 98.6 F, ½ deg lower in the early morning, ½ deg higher in the late afternoon. With severe exercise the body temperature rises 3 to 4 F, and most athletic records are made with what one ordinarily calls fever. If, however, the heat regulating thermostat in the brain is damaged or the heat load is more than the body can dissipate, the temperature may rise as high as 113 F without causing death but this is approximately the limit.

At the other extreme, prolonged exposure in cold weather can drop the body temperature in some cases to 75 F without fatal results but this limit is seldom exceeded. Similar levels apparently were reached by the nazis at Dachau in their horrible experiments with prisoners in water just above freezing. Even exposure to water at 50 F for 45 min can cause a fall of 5.5 F in body temperature and a state of collapse that is almost fatal.

There is naturally a considerable variation in regard to all of the limits that have been mentioned but the differences between the average healthy man and the prize athlete are not great. Young people are more resistant to bends and to symptoms from lack of oxygen, but youth does not seem to help in preventing blackout. Repeated exposures to bends, anoxia, and blackout are of little aid and may cause loss of tolerance. On the other hand, acclimatization to heat, if only for one week, helps enormously. Prolonged residence at high altitudes raises tolerance. There seems also to be an acclimatization to cold but it is not nearly so marked as in the case of heat.

From a paper on Limits of Factors of Safety in the Human Body, by Eugene F. Du Bois, professor of physiology and biophysics, Cornell University Medical College, which was presented at the annual meeting of the American Society of Mechanical Engineers and published in Mechanical Engineering, July, 1946.

†The Upper Limits of Environmental Heat and Humidity Tolerated by Acclimatized Men Working in Hot Environments, by L. W. Eichna, W. F. Ashe, W. B. Bean, and W. B. Shelby, Journal of Industrial Hygiene and Toxicology, vol. 27, March 1945, p. 59.

CENTRIFUGAL PUMP FUNDAMENTALS

By John J. Woolfenden
Smith, Hinchman & Grylls, Inc.
Architects & Engineers

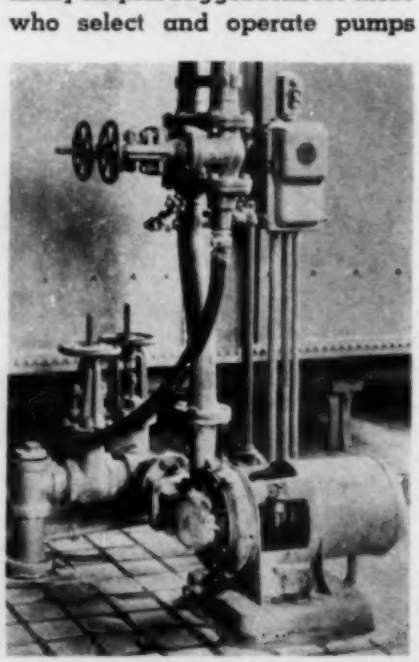
THE propriety of the statements represented by Equations 7 and 10 in the accompanying tabulation is apparent if we analyze the conditions. Let us assume an enclosed impeller of 10 in. diameter, or 31.416 in. circumference. With water supplied to the stationary impeller, the discharge takes place through a slot 31.416 in. long.

But let us further suppose that the impeller is rotated and that water is admitted to it under atmospheric conditions. If the impeller were rolled along the ground for a certain number of revolutions, it would leave a "track" and the length of this track would be proportional to the number of revolutions of the impeller. When the impeller rotates in the casing, it of course leaves no track, but the length of track it would leave, were it rolled along the ground for a corresponding number of revolutions, we may consider as the equivalent discharge orifice length or, say, as the effective peripheral length.

If the capacity (delivery) varies as the peripheral speed—and theoretically it does, provided that the capacity-head relationship is maintained—it follows that, for a given impeller, the delivery per unit of length of effective peripheral length *must* be constant and hence, since the impeller periphery contains a definite number of such units, the delivery per revolution must be constant, provided that the head-capacity relationship expressed by the affinity equations be maintained and also *providing that the pump be running at practical operating speeds and discharging,* since there is a shutoff head corresponding to each speed and also a speed corresponding to each head below which the pump will not deliver. Due to internal losses, there is likewise a speed below which the pump will not deliver against any conditions of external head, save that which imposes a sufficient pressure on the suction.

In consequence of this, in the assumed case, at 1000 rpm, this effective peripheral length would be 1000 × 31.416 or 31,416 in.; at 1200 rpm the effective length would be 37,699 in.; and so on. The equivalent peripheral length for a stationary impeller and one rotating at 1 rpm would be the same, but the stationary impeller would, of itself, have no delivery, while the rotating impeller theoretically would, although actually the internal losses of the pump would consume much more work than is represented by 1 rpm.

THE CENTRIFUGAL pump is a widely used item of piping, heating, and air conditioning equipment. In the September HPAC, Mr. Woolfenden reviewed centrifugal pump fundamentals and developed the equations governing their performance. He continues the discussion this month, with many helpful suggestions for those who select and operate pumps



The truth of the two equations, Equations 8 and 11, can be seen by comparing Equation 8 with the expression for centrifugal force, MV^2/r. If, in this expression, we regard M as a constant and substitute $2\pi rn$ for V, we have $F = 4\pi^2 rn^2$, in which, for a given impeller, n is the only variable.

Brake Horsepower Required

Since horsepower is expressed in foot-pounds and the capacity can be expressed in pounds per minute and the head in feet, it is obvious that the product of Equations 7 and 8 or of 10 and 11, which is Equation 9 or 12, respectively, must represent the "water horsepower" required. The quotient of this "water horsepower" divided by the pump efficiency is the corresponding brake horsepower required at the pump shaft.

To take an illustrative example, let us assume a pump of 14 in. impeller diameter operating at 860 rpm. The maximum theoretical head, from Equation 6, would be $[(14 \times 860)/1840]^2 = 42.8$ ft.

Now let us suppose that we wish to find out at what speed the pump should run in order

to develop a head of 60 ft maximum. From Equation 8, $42.8/60 = 860^2/n^2$, whence $n^2 = 60/42.8 \times 860^2$, and $n = 1018$ rpm.

Let us assume a pump is delivering, say, 250 gpm against a head of 80 ft and requires 8.3 brake horsepower at 1000 rpm. If this pump is run at 1160 rpm, the delivery will be $250 \times (1160/1000) = 290$ gpm against the head $80 \times (1160/1000)^2 = 107.7$ ft, and the required brake hp is $8.3 \times (1160/1000)^3 = 12.95$.

Percentage Effect of Speed Change

On the other hand, relatively slight decreases in speed or impeller diameter result in quite appreciable changes in head and horsepower. As an illustration, if we decrease either the speed or the impeller diameter of a given pump by as little as 5 per cent, the new quantities will be the following *percentages* of the original values:

Capacity	$\frac{95}{100}$	= 95 per cent
Head	$\left(\frac{95}{100}\right)^2$	= 90.3 per cent
Horsepower	$\left(\frac{95}{100}\right)^3$	= 85.7 per cent

It is to be borne in mind that the quantities obtained by use of the above formulas and equations take no account of losses; that they are theoretical and approximate only; and that the actual results may vary from them considerably.

Furthermore, it is obvious that the maximum diameter of impeller which can be used in a given casing is definitely limited and also that the minimum size that is practical is likewise limited, the latter case being governed by the fact that as the impeller diameter is decreased the clearance between the impeller and the volute (or the guide vanes, if any) is increased and the performance (and efficiency) will suffer accordingly—although the loss in efficiency will be more or less compensated for by the decrease in "brake action."

Brake Action Effect

It is well known that a rotating disc submerged in a liquid will be subjected to a retardation due to the adhesion of the liquid to the disc. Since the impeller of a centrifugal pump fulfills the fundamental requirements, it is conse-

PUMP EQUATIONS

The peripheral speed of a pump impeller can be expressed in feet per second, by the following equation, in which d is the diameter of the impeller in inches and n the rpm:

$$V = \frac{\pi d n}{12 \times 60} \quad \ldots\ldots [1]$$

According to the laws of falling bodies, neglecting the effect of air resistance, an object projected vertically upward with an initial velocity V_0 will under the influence of gravity decelerate until at the highest point of its path its final velocity V is zero. It will then start to fall, beginning with an initial velocity of $V_0 = 0$ and will return to its starting point with a final velocity V due to the acceleration of gravity which will be numerically equal to its original initial velocity. Hence we may say, letting g represent the acceleration due to gravity (32.16 ft per sec per sec) and h the height to which the body is projected or from which it falls:

$$V^2 = V_0^2 \pm 2gh \quad \ldots\ldots [2]$$

In the case of a falling body, when gravity acts with the motion, the last term is positive; when the action of gravity results in deceleration, as in the case of a body projected upward, the last term is negative

In the first case, if $V_0 = 0$, we can write:

$$V^2 = 2gh \quad \ldots\ldots [3]$$

while in the second case, if $V = 0$, we have

$$V_0^2 = 2gh \quad \ldots\ldots [3a]$$

Substituting and performing the indicated operations:

$$\left(\frac{\pi d n}{12 \times 60}\right)^2 = 2gh \quad \ldots\ldots [4]$$

$$h = \frac{(\pi d n)^2}{2g(12 \times 60)^2} \quad \ldots\ldots [5]$$

$$h = \left(\frac{dn}{1840}\right)^2 \quad \ldots\ldots [6]$$

The *capacity varies directly as the speed, or

$$\frac{gpm_1}{gpm_2} = \frac{rpm_1}{rpm_2} \quad \ldots\ldots [7]$$

The †head (pressure) varies as the square of the speed, or

$$\frac{h_1}{h_2} = \frac{rpm_1^2}{rpm_2^2} \quad \ldots\ldots [8]$$

The horsepower required varies as the cube of the speed, or

$$\frac{hp_1}{hp_2} = \frac{rpm_1^3}{rpm_2^3} \quad \ldots\ldots [9]$$

As a corollary of these, we can say that, the speed remaining constant:

The *capacity varies as the impeller diameter, or

$$\frac{gpm_1}{gpm_2} = \frac{d_1}{d_2} \quad \ldots\ldots [10]$$

The †head varies as the square of the impeller diameter, or

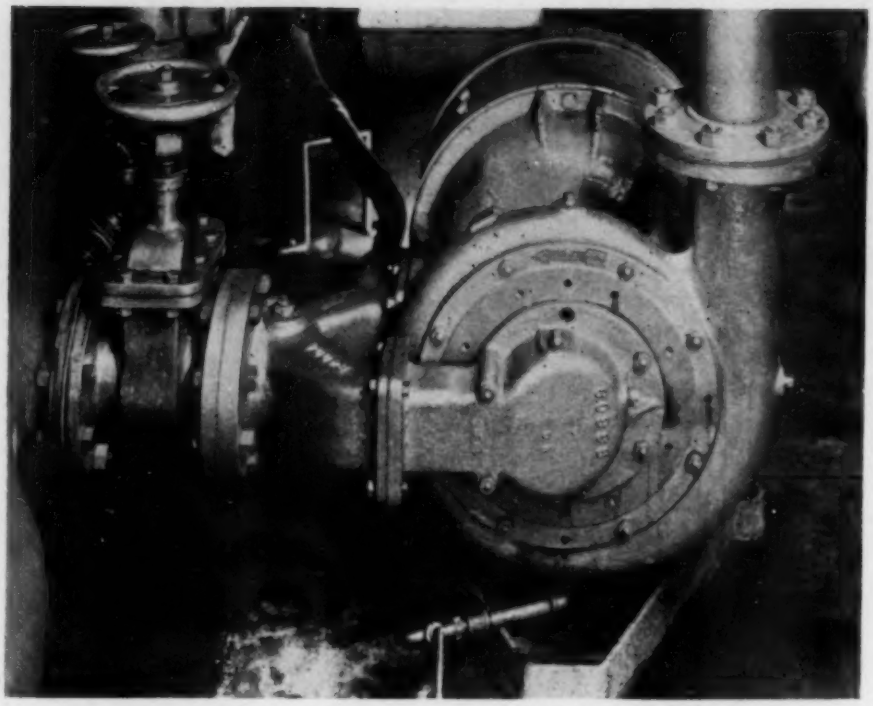
$$\frac{h_1}{h_2} = \frac{d_1^2}{d_2^2} \quad \ldots\ldots [11]$$

The horsepower required varies as the cube of the impeller diameter, or

$$\frac{hp_1}{hp_2} = \frac{d_1^3}{d_2^3} \quad \ldots\ldots [12]$$

*The capacity which the pump will deliver against the head corresponding to the speed upon which the new capacity is based.

†The head corresponding to the new speed upon which the new capacity is based. If the actual head is not that corresponding to the new speed, the capacity will not be that corresponding to the new speed. It is important to note that, unless otherwise stated, it is assumed in the subsequent discussion that, when a change of speed is stipulated, the new head will be that corresponding to the new speed.



The specific gravity and the viscosity of the liquid handled affect the horsepower requirements and should be definitely given in any pump specification.

quently subjected to the retarding action of the liquid in the casing and the term "brake action" is applied to this effect. The great importance of this phenomenon is due to the fact that this effect varies as the fifth power of the impeller diameter.**

Since a slight change in the impeller diameter will produce a marked change in the brake action and hence in the power required to overcome it, the "commercial efficiency" of the pump, or the ratio of the useful work (output) to the total work (input) is affected accordingly. For example, a decrease of 5 per cent in the impeller diameter will theoretically result in a decrease of brake action of over 22 per cent.

It is this high rate of change in the power consumed in overcoming the brake action which enables the designer of low priced multistage centrifugal pumps to avoid, within limits, expensive design and workmanship since a considerable decrease in efficiency due to their elimination can be more or less offset by the result obtained from decreased brake action. This is not to be considered as a condemnation of the low priced pump nor as an eulogy of the high priced one embodying all the refinements of design and workmanship; each has its own place in the scheme of things but, when purchasing a pump, one should know something about what he is getting.

"Refinements" in Pump Design

To take a concrete illustration, let us consider a pump to develop a maximum head of 250 ft at 1750 rpm.

If we assume that the pump is to be designed on the basis of two stages, each must develop a maximum head of 125 ft and according to Equation 6 each impeller should have a diameter of about 11.77 in. But if we make the pump four stage, we find that the corresponding impeller diameter is approximately 8.32 in.

Comparing these two diameters, we find that the brake action on one of the smaller impellers is $(8.32/11.77)^5$ or about 0.1766 (17.66 per cent) of that of one of the larger ones, or—conversely—the brake action on one of the larger impellers (the reciprocal of the foregoing expression) is about 567 per cent, or 5.67 times that of one of the smaller ones. Consequently, totaling these effects, we find that the assembly of the four smaller impellers will be subjected to only about 35 to 36 per cent of the total brake action affecting the assembly of the two larger ones. It is to be borne in mind, as above mentioned, that the foregoing considers the impeller, only, and neglects the effect of the casing friction and other factors.

Considering the results of this retarding effect, it may be said that the multistage pump which will perform a service with the largest diameter impellers (i.e., with the least number of stages), with an efficiency at least as high as those with which it is being compared, is probably the most carefully designed pump from the standpoint of "refinements."††

Unlike reciprocating, or other positive displacement types of pumps (in which the suction and the discharge functions operate independently and are separated by valves, rotors, or other mechanical devices) the centrifugal pump is open from suction inlet to discharge outlet, the only obstruction being that due to the shape and size of the water passages and to the impeller.

Any pressure applied to the fluid at the suction of the pump, while it is in operation, will be transmitted through it and will appear at the discharge as an undiminished addition to the pressure developed by the impeller. Thus a pump which will develop a discharge pressure of 40 lb with zero suction pressure will show a discharge pressure of 50 lb if the fluid is supplied to the suction at 10 lb pressure while the pump is in operation.

Should the pump be required to lift the water, the condition may be regarded as a negative suction pressure and the discharge pressure will then be the arithmetical difference between the pressure developed by the impeller and the

**The work of fluid friction can be represented by the expression fAV^2t (Carpenter; Experimental Engineering). In this formula, f is a constant, A the surface area, V the "velocity of slipping" and t the time. For unit time, this becomes fAV^2. In the case we are considering, the motion is due to rotation and V becomes a function of the disc (impeller) diameter, d, while A is proportional to d^2. Hence we can write $fAV^2 = Kd^5 \times d^2 = Kd^5$; K being a constant composed of the proper value of f, the requisite proportionality factors, etc. Other considerations affect the total of the fluid friction, but for our purpose it is sufficient to consider only the effect on the impeller.

††Since pumps are purchased on the basis of performance, whether the commercial efficiency is "up" and the power requirement "down" due to decrease in brake action or to refinements in design may be immaterial from the purchaser's point of view, as long as the pump is properly constructed and will satisfactorily perform the service required of it.

pressure equivalent of the suction lift; the term "pressure equivalent" being understood to mean that pressure which would be required to deliver the liquid at the suction of the pump at atmospheric pressure.

Sensitive to Suction, Discharge Conditions

The centrifugal pump is very sensitive to changes in either the suction or the discharge conditions and, in stipulating the conditions under which the pump is to operate, it is necessary to be definite. The design of some pumps is such that the shutoff head is not more than 5 or 10 ft different from that corresponding to rated capacity. In such a pump, a very slight change of head will very materially alter the quantity discharged.

The fact that pressure applied to the suction is transmitted through the pump, as above described, is the basis of multistage pump design. Although in a multistage pump the impellers are mounted on a shaft common to all each functions as a separate pump, the discharge of the first one in the series being conducted by suitable waterways to the suction of the second one. These units are made as nearly identical as possible, and each therefore does its prorata portion of the work. As a matter of fact, a number of separate, single stage pumps, suitably connected in series, would act in the same way.

The pressure developed is of course cumulative, that developed by each stage being added to the discharge pressure of the previous stage. Even though the pressure per stage be moderate, the resulting pressure in the upper stages may exceed that allowable for pumps of "standard" construction. This is taken into account in the design of multistage pumps and must be considered in the case of single stage pumps in series, since, for example, a pump designed for 150 lb maximum operating pressure would not be suitable for use as the last of a series of, say, three pumps, each of which develops a discharge pressure of 60 lb gage.

Specific Gravity and Viscosity

The specific gravity and the viscosity of the liquid handled affect the horsepower requirements and should be definitely given in any pump specification. These quantities do not, however, affect the head which the pump is required to develop, except insofar as the viscosity may produce a "virtual" friction effect. The head depends only upon the total *height* to which the liquid is to be raised, i.e., feet equivalent of the total pressure to be produced by the pump, plus the friction loss in feet equivalent. This will be evident from consideration of Equation 6 in which the mass does not appear and of Equation 9 in which the weight of the liquid pumped is one of the factors. Note that the total pressure referred to above also includes the suction conditions.

Handling Inflammable Liquids

A discussion of the effects of viscosity of the liquid upon the pump performance and of the precautions to be observed in installing and operating centrifugal pumps is beyond the space limitations of this article. However, there is one caution which should be observed in selecting a pump to handle inflammable liquids: *be sure* that the pump is suitable for the use contemplated and that its construction conforms to the requirements of the insurance companies and of all other competent authorities having jurisdiction over the installation. In this connection, consult also the lists of approved material issued by the insurance authorities.

Boyhood Dream Comes True

Rex E. Hieronymus, general superintendent of Aldis & Co., and a member of HPAC'S board of consulting and contributing editors, realized a boyhood dream this summer by cruising down the Illinois and Mississippi waterways from a point near Chicago to New Orleans. The crew of the 10 by 20 ft catamaran raft "Meanco"—short for "Mississippi Exploration and Navigation Co."—comprised Mr. Hieronymus, Thomas A. Roth, a fellow-member of the Chicago Engineers' Club, and their young sons Dick and Tommy, respectively.

The "Meanco" was built during the winter in the Roth basement, and passed all her trials with flying colors. She embodied a number of carefully engineered features, including a hose line for filling the tank of her outboard motor from the main gasoline tank while under way. Two parallel rows of uncorrugated oil drums, with cone sections fore and aft for streamlining, provided the buoyancy. One drum in one row was used for gasoline storage, and a drum in the other row carried the fresh water supply.

The "Meanco", fully manned and at full speed

Cooler Air and Longer Sessions

Air Conditioning Keeps Congress on Job

Announcement that the Senate and House chambers of the U. S. Capitol are to be modernized prior to January 1948 with new ceilings and new systems of lighting, acoustic equipment, and air conditioning, brings up the effect of improved working conditions on legislative activity in Washington.

The Capitol has been completely air conditioned since 1938, and it is regarded as more than a coincidence that Congress has carried its sessions into August, or later months, every year since 1938, although the traditional adjournment date in earlier times was not later than June, when the heat wave usually settles over Washington.

Some attribute the long sessions of the last eight years entirely to international complications and war. Others feel they have been due partly to the recent legislative tendency to pass emergency legislation of limited tenure, which must be studied periodically and either reenacted or abandoned. Still others — says the Air Conditioning and Refrigerating Machinery Association — see a much simpler explanation, which is that industrial and scientific advances have come to the aid of forensic discourse. Air conditioning has made the Capitol and its environs habitable during the summer months; Congress can remain on the job in comparative comfort, and consequently does.

In the 157 years since the American Congress first convened, it has been in session more than 300 days in only 15 of those years, and among these 15 are the last six completed years, 1940 to 1945 inclusive. One Congress, the 76th, taking advantage of leap year, managed to extend a session through 366 days.

Palm Leaf Fans, Bowls of Lemonade

Contrasted with the last six years are the 150 years between the first session in New York City, 1789, and 1939, when the late summer sessions became the established pattern. In this 150 year period, there were only nine years in which Congress was in session more than 300 days.

Possibly the advent of air conditioning is not an important factor, but such a statement lacks persuasiveness when one looks at the record of the sessions since it was installed, the ACRMA believes. Older Washington residents recall how the arrival of summer was announced in the Senate by the appearance of big palm leaf fans, bowls of lemonade in the cloakrooms, and by admonitions from Senators Aldrich, Allison, and Hale — who were guiding most of the legislation of an earlier generation — that the senators would have to attend diligently to the business at hand in order that Congress could get away. Such drives for early adjournment had been occurring as long as could be remembered. The heat and humidity after June were not conducive to legislative deliberation. When the government was moved to Washington in 1800, objections to the summer climate were so pronounced that suggestions were made repeatedly that the capital be moved north again.

Various attempts were made in earlier days at cooling and circulating the air in the Senate and House chambers. Electric fans were placed overhead, but correspondents in the press galleries objected that they blew the note paper and made reporting difficult. Subsequently, air intakes with suction fans were established outside of the Capitol building and the air was introduced through floor gratings in House and Senate. Exhaust fans drew the air out through the ceilings. This did not improve the temperature or humidity of the outside atmosphere and was not regarded as a substitute for the palm leaf fan. At the White House, President Taft tried to solve the problem by putting an electric fan behind a cake of ice in the warm air duct, a recourse used also at times for the House chamber. Many thought

Congress has been in session more than 300 days in only 15 of its 157 years, among them being the last six completed years. The Capitol air conditioning project was finished in 1938

it added to the stickiness of the atmosphere.

Air conditioning was begun in the House chamber in 1929 and the Capitol project was finished nine years later. One of the early estimates, made by Dr. George Calver, the Capitol physician, was that operation of the new air conditioning system in the Capitol and the three office buildings had reduced colds among the members by one-half. (From story in the Washington Post, June 13, 1938).

Congresses Usually Got Away

Whether or not the longer sessions of Congress are attributable to technological advances in indoor climate control, it is certain that air conditioning has enabled the national legislators to function without the complaints which in earlier days attended sessions that extended beyond early June. There have been numerous crises in our national history — many probably as outstanding and pressing in their day as those of the last seven years — but earlier Congresses usually managed to get away. The debates over slavery and the fighting of a war between the States kept only one Congress in Washington for more than 300 days; that was during the effort at compromise in 1850, when Clay held the legislators at their desks until he could get his bills through. The 338 days of session in 1868 — the impeachment session, when Congress stayed on watch because of its controversy with President Andrew Johnson — was marked by recesses for a total of 104 days, thus shortening the actual working session to 234 days. It is pointed out by some that being a congressman in the 1940's is quite a different matter from being a congressman in earlier days, and that measured by the time spent on the job in Washington, a pay increase for congressmen is entirely in order. Recognition of the improved working conditions at the Capitol seems to have been included in the new congressional reorganization bill, which suggests August 1 as the closing date of the sessions.

Germans Behind U.S. in Automatic Controls

German use of automatic controls for measuring temperature, pressure, humidity, and other factors is about 10 to 15 years behind current practice in the United States, according to four American experts who investigated the German industrial instrument industry under the auspices of the technical industrial intelligence division of the office of technical services, U. S. Department of Commerce. Development of industrial instruments in Germany is about 5 to 10 years behind the American industry, in the investigators' opinion.

The wartime role of industrial instruments in Germany was small as compared with that in America, the investigators reported. Apparently enough low cost labor was available to permit hand operation for most industrial measuring purposes. Also, large scale use of the "batch" method of processing in Germany permits greater dependence upon hand controls than does the "continuous" method used in the United States.

The only new material found in use by the German industrial instrument industry was polyvinyl thermoplastic, manufactured by I. G. Farben under the trade name "Igelit." The material was fabricated on a large scale into vessels, pipes, fittings, cases, and other items. By using a strip of the plastic as a welding rod, the material could be welded with a hot air jet from a special torch.

A specific gravity recorder installation on ammonium nitrate solution, using the air bubble system, was another I. G. Farben development of interest to the investigators. The range was from 1.25 to 1.40 specific gravity. Attached to some of the low range balance meters were relief seals and mercury catch pots with flexible connections, so that mercury which overflowed from the ring balance could be quickly poured out in a beaker and returned to the ring.

Flow measurement, used to guide manual control and to account for materials, is considered of great importance by the Germans, the investigators reported.

Diaphragm types of pressure gages are used in greater quantities in Germany than in the United States. Carbon steel, of 0.35 or 0.95 carbon content, hardened and tempered to 350-425 Brinell, is generally used to make the gages.

Vapor pressure thermal systems are not widely used by the Germans. Though liquid expansion thermal systems are known, they are used only to a limited extent.

Thermocouples and, to a lesser extent, resistance thermometers are commonly used to measure temperature in cases where glass thermometers are not used. Standard German thermocouple accuracies are extremely low, in the opinion of the investigators.

Little use is made of liquid density measurement. Gas density measurement, however, has been the subject of intensive development and is now widely used.

Inexpensive, nonindicating, nondirect set controllers are employed for pressure control to a much smaller extent in Germany than in the United States.

Pneumatic control appears to be in its infancy in Germany. An unusual floating pneumatic controller for flow and flow ratio, operated from positive meters, has been produced by Siemens and Halske. A small amount of throttling range is secured by closing the nozzle with a tapered needle instead of a flapper.

The investigators' 131 page report on the German plants and equipment inspected is available from OTS (Study of the Industrial Processing Instrument Industry in Germany; PB4600; photostat, $9; microfilm, $1.50.) Orders for reports should be addressed to the Office of Technical Services, Department of Commerce, Washington 25, D. C., and should be accompanied by check or money order, payable to the Treasurer of the United States.

How to Cut

Air Conditioning Costs

M. G. Kershaw,
Du Pont Engineer,
Tells How Planning Reduces Their Maintenance Charges

A view on the 14th floor of the Nemours building looking toward the east end of one of the fan rooms. Note automatic control panel boards. One panel is provided for each air conditioning system. Complete functioning of the entire control system may be watched by studying the performance of the air gages on these panels.

LOW MAINTENANCE expense on air conditioning jobs is not the result of mere guesswork. A thorough study of many design features and installation details are the factors which ultimately provide for low costs in terms of horsepower, hours of operation, cost per kwhr, cleaning, painting, lubricating, and replacing worn parts. M. G. Kershaw, heating, ventilating, and air conditioning engineer, E. I. du Pont de Nemours & Co., described, at the spring meeting of the ASRE, some of the design features and installation practices which his company uses to reduce such costs.

LOW MAINTENANCE! What a familiar phrase! We have all read many articles in recent magazines on operating and maintenance costs. Horsepowers, hours of operation, cost per kwhr, lubricating oil and grease, painting, replacement of worn parts, wages, etc., are all included.

We consider design of air conditioning systems for low maintenance as a complete planned program. The program starts with preliminary discussions leading into design calculations. Then we make detail layouts and, finally, set up operating procedures and maintenance techniques. This program is not the work of one person. It is the combined efforts and pooled knowledge of the entire company organization.

The optimum results can only be obtained when the design, safety and fire protection, medical, technical, industrial engineering, operating, purchasing and construction groups contribute the best they have to offer. At this point we want to pay tribute to two outside sources of data;—first, the ever-growing fund of information being collected and made available by the various engineering societies, and, second, the manufacturers of air conditioning apparatus who are constantly striving to improve their present products and develop new ones. These concerns are always ready to offer their assistance to our common problems.

When the entire production of a room is dependent on the continuous operation of the air conditioning apparatus, the program must be complete.

The basic nature of most of our chemical plants dictates 24 hours per day, seven-day week operation in many of the departments. Where air conditioning is required, the size of the apparatus is based on the required capacity under maximum load. In many cases the constant internal load amounts to between 75 and 85 per cent of the peak. Therefore, variations between summer and winter loads are relatively small. Refrigeration is used in summer and evaporative cooling is used during the rest of the year.

Design for Low Maintenance is Not Simple

Design for low maintenance has long passed the stage where the solution is simply to make the metal a couple of gages heavier. The final picture is the total cost in dollars out of pocket to the company over a given period. It is an item in cost of producing a pound of sal-

able material. It may affect a dividend being paid the company's stockholders. Low first cost is not always the cheapest in the overall picture.

Now, let us analyze and plan our program:

The requirement of the industrial department must be fully stated and understood. To insure uniformity of quality and continuity of production requires careful consideration as to whether the air conditioning capacity will be in one unit or subdivided into a number of units. Also, the question of a spare standby unit must not be overlooked.

On the first unit of a new plant it is not unusual for us to tie the entire capacity of 100,000 to 200,000 cfm in one unit without installing any spare standby unit. When the plant is increased, then the main ducts are interconnected so that some flexibility is included.

The real burden is placed on the plant operating men and unless the designs include features that will enable them to function efficiently, maintenance cost will necessarily be high and interruptions to production will be frequent.

Space and Access Must Be Provided

Fan rooms must be laid out to provide ample room to work on apparatus. Space must be provided so that when equipment is opened up for repairs there is some place to lay the removed parts.

You should not have waste space large enough to hold a dance—no ballrooms, but the man should have enough space so it is not necessary for him to lean over one piece of apparatus while he is working on another. You do not want a man hanging from an overhead pipe by one hand and trying to tighten a nut with a wrench with the other hand.

When there is no spare unit provided, quick access to all parts must be provided. Usually, when you must change a fan wheel in a hurry, you will find that the fan wheel and shaft are rusted together. We, therefore, check space conditions to allow removal of fan wheel and shaft as one piece.

A large door in the outside wall of a fan room should be considered for removal of equipment. If the fan room is above ground level, then consideration of installing a permanent outrigger is important.

Where the plant is located adjacent to a large city, it may be far more economical to rent a caterpillar boom crane for the occasional emergency. As this equipment may not be available on short notice, it may be a better policy to have the facilities available for immediate use in order to guarantee minimum loss of production due to air conditioning system outage. This item must be considered for each individual case.

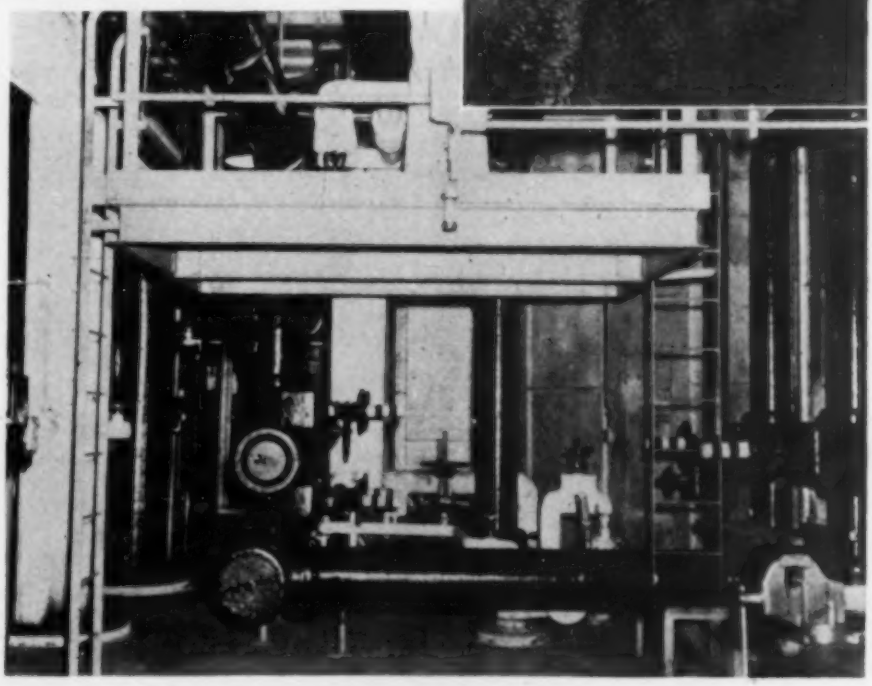
All equipment should be on suitable foundations. High pressure fans on flimsy supports do not contribute to low maintenance.

Where fan wheels are mounted directly on motor shafts, the base under the motor should be extended down to the floor line. The cantilever type of base under the motor contributes to motor bearing maintenance.

Fan housings equipped with doors provide for quick inspection and ready access for repairs or painting.

Split housings on large fans are sometimes necessary to allow for removal of wheel and shaft in the headroom available.

Fig. 1—A side view of an air conditioning unit showing the piping layout. Note platform for access to overhead automatic control valves.



Drains in fan casings where moisture or acid are handled reduce maintenance.

Fan shafts in conditioned air flows are wrapped with cambric tape to prevent rust getting in the air stream.

Bearings and fan inlets are guarded so that operators may inspect and lubricate without any danger of bodily harm.

Drains should also be provided in the bottom of spaces on both upstream and downstream sides of air washers.

Close supervision is needed to see that these spaces have a good slope to the drains. Pools of water on floors inside casings do not encourage careful inspection.

Wherever walks in casings can be provided, use the fan room floor as the bottom of the casing.

Our transmission specialist is consulted in reference to proper

Fig. 2—A trough on the inlet end of the washer catches drip from perforated baffle. Note separate ball float tank to control water.

Fig. 3—Pressure vestibule with outer door standing open to show inside door.

bearing specification. Bearings located outside of casings receive more attention. We have sleeve, roll and ball bearings in operation. Horizontally split bearing housings are preferred by the operating men.

Washers have quite a varied length of life. We have one that was installed on a ventilating system back in 1918 and is still operating. The only repairs outside of painting were two new sets of spray nozzles.

Then we have some 10,000 cfm air conditioning units that lost their tanks in six years. This was a freak condition caused by a down draft in a light court which pulled stack gas down into 6 units. Units located in a building across the street at the same level as the top of stack have not shown any sign of attack.

Cast iron spray water piping in these units lasted two years. Red brass spray water piping installed to replace the cast iron shows no sign of corrosion.

Standard light gage pans have not worked out too well. They retard the men in cleaning due to the buckling changing location as the men walk around. We now use ¼ in. welded steel plate tanks. The bottoms of tanks are sloped toward the drain pipe.

Tanks Are Often Slimy

The insides of tanks are usually slimy and men are apt to slide around when entering. The operating men in one plant installed grating steps inside the washer from the access door down into the bottom of the tank. Be sure that access doors are ample size. When cleaning down washers, men usually are in rubber boots, rubber raincoats and hats, and, at the best, it is a clumsy task to get through the doors.

The piping between the washer and pump should not interfere with access to the side of the washer. Two screens in outside projection of the tank allow changing screens frequently without shutting down the washer. Where large size screens are handled, an overhead block and fall should be installed to provide easy removal.

A separate small tank for the ball float allows working on the valve without shutting down the washer.

Run-down of spray back-lash on entering perforated baffle plates can be prevented from wetting the floor by installing a gutter trough below the angle at the top of the tank and draining the trough back into the washer.

In some localities washer water must be treated and this part of the program is set up by our water treatment specialists who provide specifications as to materials, quantities, and frequency of application.

Algae is quite a pest in some of our plants. In an office building job where the dewpoint is maintained at 54 F in the summer, and 45 F in the winter, there is a much faster growth in the summer season, approximately twice as rapid as during the winter.

In one plant algae is so troublesome that the washer tank and eliminator are hosed down once a week. On this particular plant the washers were provided with a removable section in the top over the eliminator section. When this section is removed, more ready access is obtained for cleaning eliminators. This did not answer the problem 100 per cent because, due to lack of headroom above this section, it was impossible to do a good job of swabbing down the eliminators.

Fig. 4—Inside filter chamber showing access platform and ladder for easy removal of filter cells

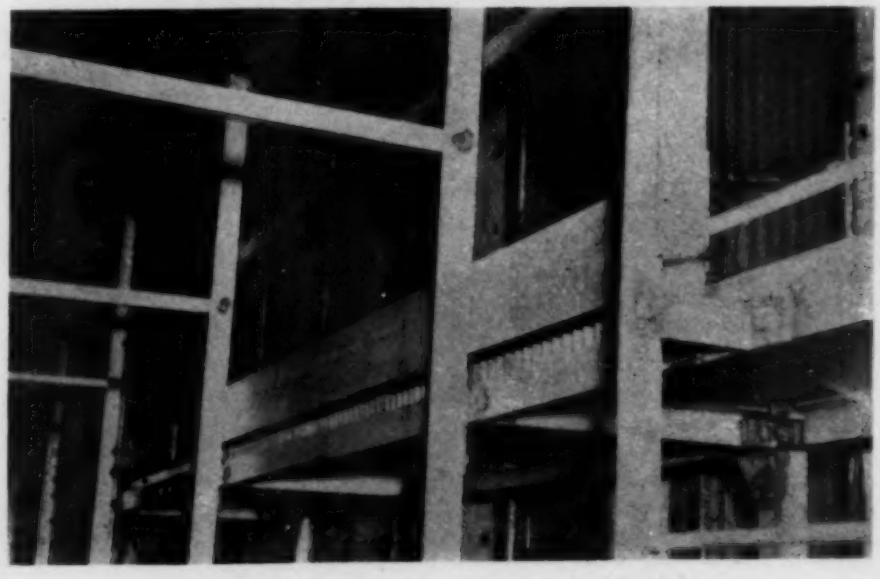
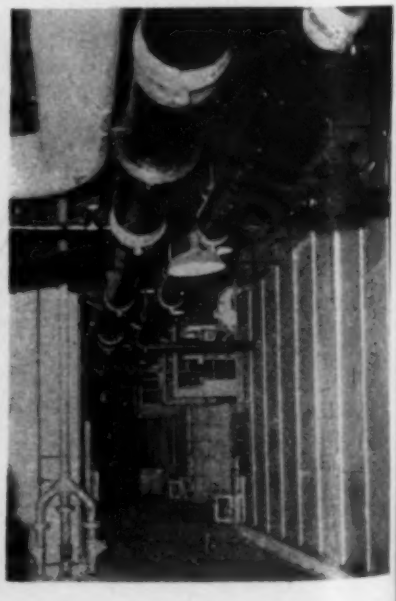


Fig. 5—View showing how piping is arranged so as not to interfere with access doors in air casings.



After 17 years it is now necessary to replace one of the washers at this plant. The present internal water piping and spray nozzles will be reused. A new tank, sides and top and eliminators are to be installed. The new eliminators will be so arranged that each can be individually lifted out of its slots and moved sideways. With this arrangement it is expected that both sides of each eliminator can be thoroughly cleaned for their full depth. At present, the hosing is only effective back to the second bend. As these are five-bend eliminators, the middle bends cannot be reached without dismantling the entire bank of eliminators which would take too much time as a weekly procedure.

Heater coils with copper tubes and fins coated with 85 per cent lead and 15 per cent tin stand up well for the average atmosphere.

Heater coils built entirely of aluminum have been used where required by acid fumes. Stainless steel coils have been considered but to date none have been installed in any of our plants.

Filters present a maintenance problem which naturally varies depending on type. The throw-away type is either handled by having an outside concern do the cleaning or it is included as part of the general plant maintenance.

In plants where replaceable media are used, the servicing comes under plant maintenance. Vacuum cleaning, air blowing, and other methods are tried to lengthen the life use of the media.

Access Doors in Duct Work

Duct work should be provided with many access doors for inspection and cleaning. The periodic cleaning of ducts should be part of the regular maintenance schedule. Product contamination and fire spread hazard are always present in dirty ducts.

Instead of it being necessary for operators to climb all around to see air gages on control valves, we centralize—on a panel—gages showing branch line pressures to all valves and damper motors. A complete diagrammatic sketch with a complete description of control functioning is also installed on the panel. An operator can stand in front of these panels and tell if the control is functioning properly. This minimizes the time an operator must spend at each unit and also enables him to locate the seat of trouble in the shortest time.

We believe that good automatic control systems should be installed and allowed to function automatically. If an operator is going to spend his time tinkering, you are not realizing on your control investment.

A factory job is not, after all, fundamentally a showplace so our temperature control panels are kept plain and all fancy trimming is omitted.

Types of metal that should be used are specified by our metallurgical section of the technical engineering group. It is very impor-

EQUIPMENT	NAME OF PART	LUBRICANT	AMOUNT USED	FREQUENCY	CHANGE INTERVAL	METHOD OF APPLICATION	REMARKS
Brine Pump	Bearings	#2 Grease	2 shots	3 months	Yearly	Gun	Do not overgrease.
Ammonia Compressor	Cylinder and Crankcase	#1 Oil	Maintain level	Daily	6 mos.	Circulating	
Air Compressor	Crankcase	#2 Oil	Maintain level	Daily	6 mos.	Circulating	Observe oil color.
" "	Cylinder	#2 Oil	4 DPM	-	-	Force feed lubricator	Keep lubricator full.
Flexible Coupling	Reservoir	#5 Oil	Maintain level	-	Yearly	Oil hole	Inspect each shut-down.
Water Pumps	Bearings	#2 Grease	2 shots	3 months	Yearly	Gun	Do not overgrease.
" "	Packing	#5 Grease	2 shots	Twice/wk.	-	Compression cup	
Fans	Sleeve Bearings	#2 Oil	Maintain level	Weekly	Yearly	Constant level oiler	Do not fill oiler too full.
Fans	Ball Bearings	#2 Grease	4 shots	3 months	Yearly	Gun	Do not overgrease.
Unit Heaters	Ball Bearings	#3 Grease	2 shots	2 months	Yearly	Gun	
Motors	Ball "	#2 Grease	2 shots	3 months	Yearly	Gun	Do not overgrease.
Motors	Sleeve Bearings	#2 Oil	Maintain level	Weekly	Yearly	Constant level oiler	Do not fill too full.

Fig. 6—This is a typical lubrication chart which is prepared before start-up and is used as a guide by the plant operating personnel.

Fig. 7—A typical schedule of shut-down giving unit number and date for inspection well ahead of taking out of service.

INSPECTION SCHEDULE FOR AIR CONDITIONING UNITS

Unit	Date	Time
306 Third Floor Exhaust	Jan. 9, 1946	9:00 to 11:30 a.m.
307 Third Floor Exhaust	Jan. 9	9:00 to 11:30 a.m.
Main Office	Jan. 11	Arranged
#2 Spinning Supply	Jan. 16	9:00 to 11:30 a.m.
3rd & 4th Floor Supply	Jan. 23	9:00 to 11:30 a.m.
#3 Textile	Jan. 30	9:00 to 11:30 a.m.
#2 Textile	Feb. 6	9:00 to 11:30 a.m.
#1 Textile	Feb. 13	9:00 to 11:30 a.m.
306 Third Floor Exhaust	Feb. 20	9:00 to 11:30 a.m.
307 Third Floor Exhaust	Feb. 20	9:00 to 11:30 a.m.
Main Office	Feb. 22	Arranged
#1 Spinning Exhaust	Feb. 27	9:00 to 11:30 a.m.
#2 Spinning Exhaust	Mar. 6	9:00 to 11:30 a.m.
#1 Spinning Supply	Mar. 13	9:00 to 11:30 a.m.
#3 Textile	Mar. 20	9:00 to 11:30 a.m.
#2 Textile	Mar. 27	9:00 to 11:30 a.m.
#1 Textile	Apr. 3	9:00 to 11:30 a.m.
306 Third Floor Exhaust	Apr. 10	9:00 to 11:30 a.m.
307 Third Floor Exhaust	Apr. 10	9:00 to 11:30 a.m.
Main Office	Apr. 12	Arranged
#2 Spinning Supply	Apr. 17	9:00 to 11:30 a.m.
3rd & 4th Floor Supply	Apr. 24	9:00 to 11:30 a.m.
#3 Textile	May 1	9:00 to 11:30 a.m.
#2 Textile	May 8	9:00 to 11:30 a.m.
#1 Textile	May 15	9:00 to 11:30 a.m.
306 Third Floor Exhaust	May 22	9:00 to 11:30 a.m.
307 Third Floor Exhaust	May 22	9:00 to 11:30 a.m.
Main Office	May 24	Arranged
#1 Spinning Exhaust	May 29	9:00 to 11:30 a.m.
#2 Spinning Exhaust	June 5	9:00 to 11:30 a.m.
#1 Spinning Supply	June 12	9:00 to 11:30 a.m.
#3 Textile	June 19	9:00 to 11:30 a.m.
#2 Textile	June 26	9:00 to 11:30 a.m.
#1 Textile	July 3	9:00 to 11:30 a.m.

tant that all surfaces be thoroughly cleaned down to the base material before the priming coat is applied. Any oil or rust left on the surface means an early repaint job. When a manufacturer is rushed to make shipment, apparently this cleaning operation is let slide. Every time this occurs we must remove paint and start over.

Operating Instructions Furnished

Operating procedures include instruction of the personnel in their duties and they attend conferences where their knowledge of the subject is improved by lectures, etc.

Our lubrication specialist prepares a chart listing equipment, name of part, lubricant, amounts used, frequency, etc. This information is now furnished the plant before it goes into operation.

Shut-downs for maintenance work should be based on a pre-arranged schedule which has been discussed with all departments. For efficient use of time out, a well planned line of attack must be considered.

Copies of the schedule are sent to all interested parties so they can plan production accordingly.

Before we go into the maintenance techniques, let us look over three plants to get a general picture of the extent of our problems.

The Du Pont building has 435,900 sq ft of net rentable space which is air conditioned.

The Nemours building has 401,300 sq ft of net rentable space which is air conditioned.

Combined installed refrigeration for the two buildings totals 2,800 tons. Maximum load to date is 2,300 tons total.

A force of 14 men working over three shifts takes care of the entire job of operating and maintaining the air conditioning and ventilating systems in both buildings including the hotel which is in part of the Du Pont building.

There are 56 air conditioning systems in the Du Pont building, totaling 540,000 cfm. The Nemours building has 20 systems, totaling 388,000 cfm. Including the system in the hotel, we handle approximately 1,000,000 cfm of conditioned air.

If one man were to make the complete trip through both buildings, just stopping at each unit for five minutes, it would take him 6 hours to cover the circuit.

On comfort systems we do not install temperature and humidity recorders. If these readings are required they are taken at the desired locations.

At present, the Martinsville plant has 11 air conditioning systems with a total capacity of approximately 680,000 cfm. The systems vary from the conventional comfort job to industrial systems requiring large quantities of air with resultant high air changes.

The cost of maintenance, including operating personnel per square foot of conditioned space for the nylon plant at Seaford, Del., is approximately the same as for the office buildings. The owning and operating cost is naturally higher because of the higher heat load per square foot, which requires larger units. These figures are not given as they would vary from any other manufacturer's expenses due to difference in labor costs, local conditions and rate of depreciation, etc., and, therefore, would be of little value in this paper.

Plants where acid conditions are present have quite a variable cost depending on whether the metal is allowed to corrode and be replaced at intervals or whether special acid-resistant materials are installed. As the costs between two similar plants are apt to vary, we have not included rayon or cellophane plants.

Overhaul Schedule

Now let us review maintenance techniques. At one year frequency, each air conditioning unit is given a type "B" overhaul. This consists of inspection and minor repairs such as:

Minor Construction—Mop floors with asphalt
- Fan chamber
- Spray chamber
- Intake chamber
- Spray tank

Paint Dept.—Paint
- Fan and chamber
- Spray chamber

This type "B" overhaul takes approximately 2½ days outage time and costs, including material and labor, about $500.

At five year frequency, each air conditioning unit is given a type "A" overhaul. This consists of inspection and the following overhaul:

Electrical Dept.
- Exhaust fan motors
- Supply fan motors
- Spray pump motors
- Electric controls

Pipe Dept.
- Valves, heat exchangers and traps.

Minor Construction
- Relay floor in—
  - Fan chambers
  - Spray chambers
  - Intake chambers
  - Spray tanks

Paint Dept.
- Scrap and paint—
  - Fan chambers
  - Spray chambers

Millwright Dept.
- Exhaust fan bearings and couplings
- Supply fan bearings, drive and couplings
- Spray pumps
- Removing and replacing eliminator plates

Air Conditioning Dept.
- Cleaning eliminator plates, duct and spray nozzles.

Instrument Dept.
- Instruments and dampers

This type "A" overhaul takes five days outage time and the cost of material and labor is approximately $1,250.

In summarizing, maintenance is a definite reflection of the amount of thought included in the original design. Systems must be turned over to the operating men in first-class mechanical condition. They will then take pride in continuing to keep it functioning at maximum efficiency.

When you are selling quality products, every piece of equipment must contribute to this goal.

In the words of one of our works engineers, "if a system is turned over to us in proper condition, it should last forever if my force does the correct type of maintenance job and the only reason for removing the system should be obsolescence."

PRACTICAL POINTER

Explosionproof Heaters

RONALD L. IVES DESCRIBES GAS HOUSE EQUIPMENT AT METEOROLOGICAL STATION

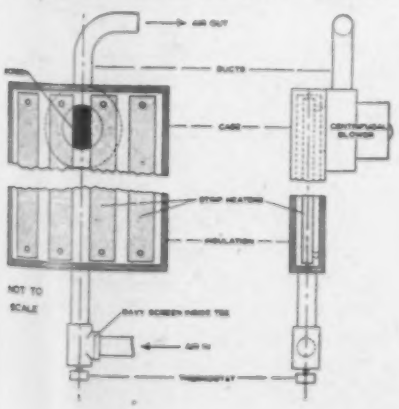
FAILURE of hydrogen tanks from extreme cold is a very infrequent occurrence, but failure of regulators, hoses, and balloons, particularly those made of synthetic rubber is a frequent and annoying occurrence during subzero weather.

Recurrent minor injuries to personnel at a western meteorological station, from the failure, or handling, of very cold balloon-inflation equipment, led to experiments with heaters for the hydrogen house that would keep the temperature within a comfortable range and still not constitute a fire or explosion hazard should a tank of hydrogen leak.

Although a forced circulation hot water heating system would probably be the ideal solution to the problem, labor requirements and initial cost made alternative construction necessary. Tests showed that an electric heating system, with forced air circulation, could be equipped with Davy screens in the air ducts, so as to be entirely safe for this purpose.

Construction features of the heater are shown in Fig. 1. The housing was made of 1/16 in. sheet steel, bent and spot welded. The interior of the case was insulated with ½ in. sheeting, bolted in place. Strip heaters were supported above the sheeting with bushings, to permit even radiation and air circulation. Air ducts were of 2 in. thin wall electrical tubing, which, because of its smooth interior, is about as effective as 3 in. stovepipe. The centrifugal blower was an overvolted automobile heater blower. A more rugged blower, having a ¼ hp motor, would be more suitable. Supports were made of ¾ in. iron pipe. The conduits protecting the wiring from weather, and the air ducts, also acted as supporting members. A general view of this heater, after a year's service, is shown in Fig. 2.

Fig. 1—Mechanical design of gas house heater. Electrical connections not shown. Note placement of screens in intake and outlet ducts, and elevation of heaters above the insulation



Electrical control of the heaters and blower is obtained through a thermostat mounted in the cold air intake duct (bottom of tee, Fig. 1 and Fig. 2). This is a commercial single pole, double throw bimetallic thermostat. Coupling the thermostat to the heaters and power line is a relatively new control mechanism, so arranged that no heater power passes through the thermostat contacts, and no current flows in the initial control circuit except at the instant of change.* This principle, as here applied, is shown diagrammatically in Fig. 3. Tracing of this circuit, described in detail elsewhere,* shows that when the thermostat makes contact for the first time on either side, the latching relay changes position, but that additional closures of the same contacts produce no further effect. This arrangement makes for long contact life and minimized radio interference.

As the centrifugal blower need only operate when the heater is on, the stepdown transformer supplying it is shunted across the heaters. Use of a continuously operated fan was considered, but as thermal stratification within the gas house was not objectionable, intermittent operation was deemed adequate.

*Ives, R. L., An Improved Thermal Control Circuit, Rev. Sci. Insts. 16, No. 10, 1945, 294-296.

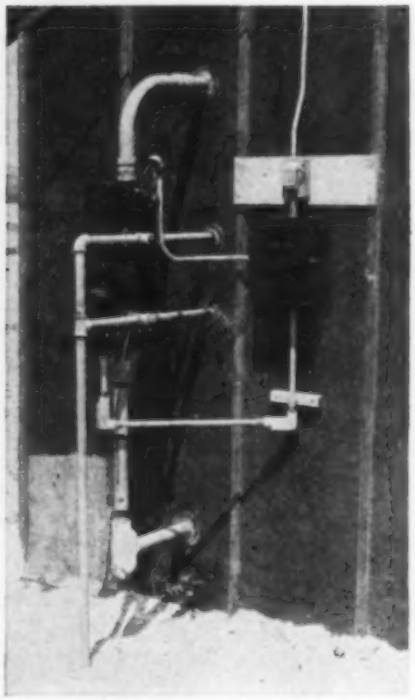


Fig. 2—General view of heater, showing use of large thin wall conduit as air ducts. Large black box contains strip heaters. Blower is at top of heater box. Smaller box on wall at right contains control mechanisms

Capacity and Performance

Because of a large radio installation in the vicinity of the gas house, spark absorbers, consisting of a 2-MF paper condenser and a 100-ohm resistor, were shunted across all contacts. This arrangement, plus enclosure of all power wiring in steel conduit, plus careful grounding of the secondary circuit, eliminated all radio interference.

Tests of this heater during the

HEATERS OF this general type seem ideal for use in locations where the atmosphere may be explosive, and where hot water heaters cannot be used, says the author. This article has been taken from the Bulletin of the American Meteorological Society (with the approval of the society and the author). It was published in that bulletin by permission of the Chief, Chemical Warfare Service.

coldest weather of a mountain winter showed that it could keep the temperature inside the gas house more than 100 F above that outside with about 50 per cent operation. This allows an adequate margin of safety for any conditions likely to be encountered anywhere. Interior volume of the gas house was about 800 cu ft, and the building was lined with plaster board.

When an explosive mixture of hydrogen and air was passed through the heater, it could be intentionally ignited at any point, but the ignition would not spread past a Davy screen. It was not found possible to ignite the gas within the heater by means of the electrical connections until an arc was deliberately produced. This would not normally occur in use, and could last only a short time, as the fuses would blow.

Maintenance consists of removal of sand from the air ducts monthly, and cleaning of the relay contacts occasionally. Life of the heaters and motor is about one year of continuous service, or more than two years of intermittent service.

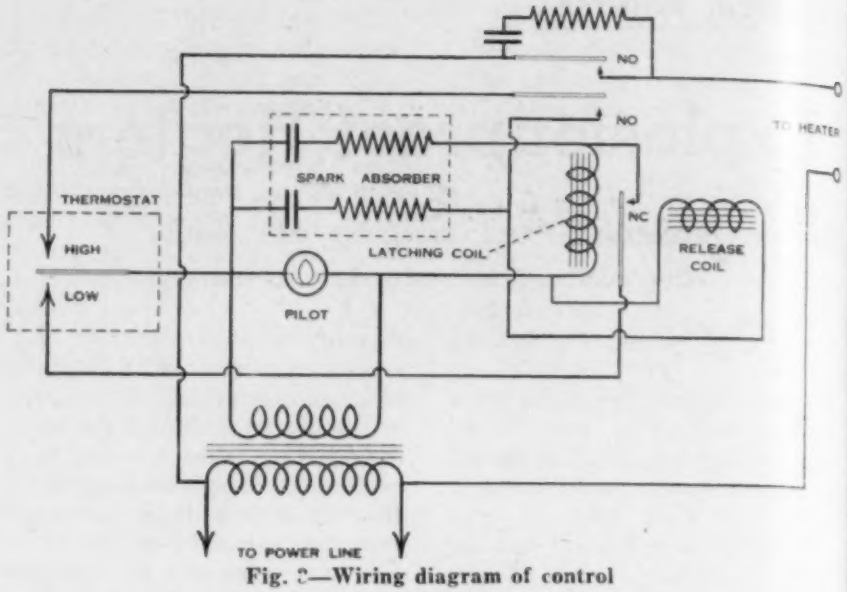


Fig. 3—Wiring diagram of control

Conclusions

Heaters of this general type seem ideal for use in locations where the atmosphere may be explosive, and where hot water heaters cannot be used. Installation of such heaters in gas storage houses at meteorological installations subject to severe cold would very greatly facilitate pilot balloon observations, and would reduce or eliminate injuries to personnel from handling and failure of cold equipment.

Federal Code on Mine Safety Covers Operating Conditions

A COAL MINE safety code, drawn up under the terms of the contract between the United Mine Workers of America and the U. S. government and officially known as the Federal Mine Safety Code for Bituminous and Lignite Mines of the United States, covers "practically every phase of operating conditions and practices in coal mines," according to the Department of the Interior. The code was formulated by Dr. R. R. Sayers, director of the Bureau of Mines, with the assistance of representatives of mine operators, the union, and the Coal Mines Administration.

Among the more important provisions of the code are the following on *ventilation and gases.*

The code does not classify all mines as "potentially gassy," but distinguishes between those where gas has been found by accurate detection methods in the past, and those where none has been found. All coal mines, regardless of whether gas has or has not been found, must be examined for explosive gas (methane) and other hazards at least once a day within four hours before the workers enter the mine. In mines where methane has been detected previously, examinations by "fire bosses" or other accredited officials must be made before each shift starts to work in case there is more than one shift of workers. In addition, all mines must have a thorough examination once a week for gas, hazardous roof, and other dangers which might not be found during the preshift examinations.

In requiring a sufficient volume of air at all working places underground to dilute and carry away gases and provide fresh air for miners, the code also prescribes regulations for the construction and maintenance of ventilating devices such as stoppings, doors, line brattices, overcasts, and undercasts. Safeguards for the main ventilating fans are stipulated, and underground booster fans cannot be installed in the future except after a special investigation and approval. Underground blower fans can be operated under certain conditions. The air underground must contain at least 19.5 per cent oxygen, and the code prescribes the limits of methane which air returning from a split may contain before the ventilation is improved or the men withdrawn from the mine.

125,000 ENGINEERS GET EARNINGS QUESTIONNAIRE

The earnings and economic status of professional engineers before, during, and after the war is the subject of a survey being made cooperatively by six professional societies and the U. S. Department of Labor. The survey will supply information for the years 1939, 1943, and 1946, the data being collected by means of mail questionnaires.

Letter from South Africa Cites Need for Industrial Ventilation Data

"OPEN FOR DISCUSSION"

THE EDITOR—Study of published matter in HPAC and the ASHVE Journal section over a number of years has led me to the conclusion that the important subject of industrial ventilation has received far less than the attention it deserves. We have had numerous articles on *air conditioning* for factories, and many others on such specialized applications as exhaust from plating tanks, grinding and buffing wheels, etc., etc., and on local cooling, but it seems to me that the subject on which we have had least comment is that of the maintenance of reasonably comfortable conditions in ordinary factories where heat loads are not excessive and special fume and dust problems do not arise.

It seems to me that ordinary industrial ventilation is one of the most important branches of our art. When all is said and done, not many factories are air conditioned and it is probable that comparatively few of them ever will be. Most factories will continue to be ventilated by natural means or to be served with mechanical ventilation and I feel that engineers in this field who have to provide recommendations for the accomplishment of comfortable factory conditions have not been very well served in the matter of basic data.

In most ordinary cases there is no great difficulty in establishing the air quantities necessary to provide in the factory air at a given maximum temperature rise above outside shade temperature and there are adequate data for the provision of any desired degree of air movement. However, even these factors are far from providing an adequate answer to the problem and radiant heat exchange must be taken into account.

Unlined Corrugated Roofs

Writing this from South Africa I am not aware of the extent to which unlined roofs of corrugated roofing material are employed in the United States but one hopes that their use is uncommon. Unfortunately it is very common indeed in this country and I have long felt the need of basic data adequate to enable me to present to clients a clear picture of the relative comfort possible in the cases of factories with lined roofs and unlined roofs. By lined roofs I refer, of course, to a lining of building board on purlins below the roofing material, and providing a mean air gap of about 2 in.

In considering a problem of this type it is necessary first to determine the temperature of the underside surface of the roofing material. From the conclusion arrived at the heat emanating from the underside of the roof must be split up into convected heat and radiated heat. The former can in most cases be taken care of by extract at roof apices.

Radiant Heat from Roof

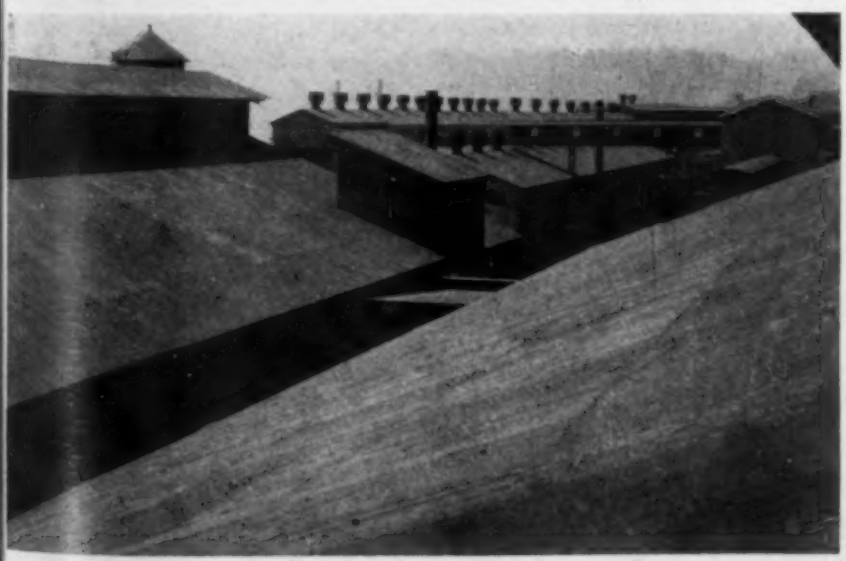
The radiated heat will, of course, fall upon walls and floor but it is surmised that very little of this heat is ultimately convected to the room for the reason that during the short duration of its incidence it is not sufficient to overcome the storage effect of wall and floor structures and it is doubtful that, in normal cases, this radiation would be sufficient to raise walls and floor to daytime room temperatures.

However, the important aspect of this heat radiating from the roof is the direct radiant heating effect upon persons. This heating effect (underside roof temperature being known) may be arrived at from calculations of mean radiant temperatures, but when we have arrived at the MRT we are then faced with the problem of adjusting the effective temperature accordingly and published data offers us no very accurate means of doing so.

Operative Temperature

The formula for "operative temperature" given on page 551 of the 1946 Heating, Ventilating, Air Conditioning Guide looks like a useful approach to the matter, but it is obviously evolved primarily for winter heating and for use in conditions fairly close to winter optimum, It is obviously imperfect and breaks down at high effective temperatures. It is indicated that at high effective temperatures, when the metabolic heat loss by evaporation is very much higher than that by radiation, the effect of MRT on comfort is less pro-

"Ordinary industrial ventilation is one of the most important branches of our art."



nounced. Nevertheless, the fact remains that a person in a high MRT may be subject to a considerable radiant heat gain and if this is to be offset by higher evaporation it can only be accompanied by greater fatigue and discomfort. One imagines that the fatigue will be more noticeable in the cases of persons sedentarily employed or at light work and it seems absolutely necessary that we should discard the habit of clinging to effective temperature as the only comfort index, and should take MRT very seriously into account in summer ventilating problems.

Lest it should be felt that I exaggerate this factor I may state that I know of *many* factories in this country (where summer outside air dry bulb temperatures are normally between 80 and 90 F) provided with unlined roofs with underside temperatures which would be considered sufficient to maintain comfortable operative temperatures under New York winter conditions.

Papers printed recently in the ASHVE Journal Section on the subject of physiological response to high effective temperatures have made no reference to MRT'S under which the tests were conducted and it seems to me that the conclusions reached are of doubtful value for that reason.

We are given in the Guide a rough indication that effective temperature should be increased by 0.5 F for every 1 deg rise in MRT, but this is obviously a very rough method and confirmation that it applies in the higher effective temperature ranges is needed.

We Need Answers to These

I consider that if we are to arrive at justifiable conclusions in industrial ventilating work we must have answers to the following questions:

1) What are the normal reflectances and emissivities of corrugated galvanized iron and corrugated asbestos roofing materials?

2) To what extent should normal forced convection coefficients be modified in cases of:

a wind at velocity parallel to corrugations?

b wind at velocity at right angles to corrugations?

3) What are the mean radiant temperatures in relationship to dry bulb temperatures in the cases of published effective temperature scales?

4) What formula must be used for an operative temperature scale embracing the factors of dry bulb, wet bulb, air velocity, and MRT?

5) Can a suitable scale be prepared relating to readings on a standard instrument responsive to all four factors?

6) What are mean surface temperatures for body and clothing under varying conditions of operative temperature?

7) In the case of a very large factory, where the roof and floor may be considered virtually as two parallel surfaces of infinite size (i. e., the influence of wall area on MRT is negligible) is it correct to assume that the radiant heat on persons is independent of roof height?

8) Tables indicate a maximum solar heat on horizontal roofs of about 280 Btu per sq ft. Is it correct to assume that on the outside, heat is lost from the roof by convection only or is a portion of the incident heat re-radiated, in addition to that which is reflected? If a proportion is re-radiated skyward, what is a basis for computing it?

As a final reflection on published data, my own impression after carrying out a considerable amount of industrial ventilating work is that not sufficient "comfort" credit is given to the factor of air movement in the medium effective temperature ranges and it seems to me that at medium high temperatures moderate air movements are capable of compensating for high temperatures to a greater extent than is indicated in published tables.

Summarizing, I feel that the question of industrial comfort conditions generally, with particular reference to radiant heat exchange, still cries out for considerable research and that field engineers are badly in need of curves and reasonably concise formulas.

I do hope that such research is contemplated and that, in the meantime, some of your contributors will help to "ventilate" what seems to me to be an extremely important subject.—*R. J. S. Caldwell*, Thermaire, Ltd.

JOB EVALUATION STANDARDS FOR OFFICE WORK

THE EDITOR—Recently Ralph Martin McGrath gave me a copy of the July HPAC containing his article on job evaluation. This is one of the most interesting things that has come to my attention along these lines. I have no direct interest in the type of factory job evaluation on which Mr. McGrath writes but I am interested in similar work in the office.

Do Same for Offices

It seems to me that something of the same sort could be done for offices. Certain types of office work are so accurately measurable that it should be possible to establish rather sharp boundaries to the various grades of worker annoyance mentioned by Mr. McGrath. Some of the subjects he treats—such as fumes, for instance—would not apply to office work but there are undoubtedly other types of worker annoyance that would make their appearance in office work.

Someone would do a very great service to office managers if they would conduct a series of carefully controlled experiments that would determine the effect of these various worker annoyances in the office singly and in combination. The high degree of measurability of typing output makes that seem the logical standard to use.

Pardon Intrusion

Please pardon this intrusion of a letter from someone outside your field. However, it seems to me that perhaps the suggestion might bear fruit.—LOUIS A. LESLIE, executive secretary to the president, Gregg Publishing Co.

WHEN ENGINEERS gather to hear a paper or talk, there comes a time when the meeting is thrown "open for discussion." We follow this custom in these columns, which provide an opportunity to comment on articles published; discuss other topics of interest to heating, piping, and air conditioning engineers and contractors; ask questions; make suggestions, etc.

Variation of Conditions During the Year Affects Job Evaluation

THE EDITOR — Air conditioning engineers everywhere will, of course, be vitally interested in the material presented in Ralph Martin McGrath's article on job evaluation in the July HPAC. The concept of being able to make a direct, measurable, predetermined saving in payroll by the providing of a more or less degree of comfort with air conditioning in the working space, would doubtless be a boon to the industry, and a delight to its engineers who seek an economic justification for the cost of such projects.

There is one point in the discussion, however, which might require some clarification by the author. In most non-air conditioned spaces the conditions are neither "bad" all the time, nor "good" all the time, many such spaces becoming intolerably hot on the worst summer days, but being ideally comfortable in winter.

In his listing of the "degrees of disagreeableness" for atmospheric conditions, Mr. McGrath has not mentioned this factor of variation in conditions with calendar time, but the job evaluation staff of my own company has apparently found this to be one of several "stumbling blocks" in trying to evaluate accurately the effect of a worker's environment on his overall job worth. In other words, if a worker in a certain building is given a premium rate due to intolerably hot conditions in summer, will this premium be withdrawn when more comfortable winter arrives? If not, will workers, in a nearby building not so uncomfortable as the previous example in summer, but entirely comparable in winter, be satisfied to receive less pay for a job comparable in every respect for more than half the working year?

A Deficiency in Research Data

It seems to me that the author has also pointed up a serious deficiency in the research data which has been accumulated by the ASHVE. There is no doubt a need for accurately evaluating the purely psychological "degree of disagreeableness" factor, due to air conditions in working spaces, and the effect this factor should have on the worker's pay envelope. Similarly, there would seem to be an even more pressing need for accurate data showing the effect of these air conditions on the production efficiency of the workers. Several technical magazines, and journals of engineering societies, have reported data in this field, many show improvements in worker efficiency higher than 50 per cent (i. e., 50 per cent more production per man hour). These reports are far from consistent, however, and there are no doubt many applications where no improved worker efficiency will result from improved air conditions.

A research program by the ASHVE which would clearly prove the conditions under which improved worker efficiency would result from air conditioning, would likewise be reflected in the worker's pay envelope, and would be of inestimable value to engineers, and management in this field.—H. A. MOSHER, engineering unit supervisor, Eastman Kodak Co.

Floor Construction for Radiant Heating

THE EDITOR—The article on Improved Floor Construction for Radiant Heating, by John E. Peterson, in the July HPAC sounds exactly as one would expect when written by an advocate of warm air heating.

Frankly, the article in question is unfair to radiant heat in many ways. I can show Mr. Peterson 97 deg room temperatures in buildings of "solar construction" that are forced air heated. That particular difficulty is a weakness of solar construction.

Also the fact, "that snow was found to be melted for a distance of 2 ft from several structures," is not uncommon with structures heated by other methods.

Another statement which I question is that "most slab areas are partially excavated or scraped and the slab lies on a clay base of unkown moisture content." In this area, (Memphis), at least, floor levels with concrete slab construction are up two steps from grade level, or about 12 in. (one step to porch or stoop and one step to floor level). The only excavating is for the footings and foundation walls; the grade in the center of the building is not disturbed. Excavated dirt from foundation walls is generally thrown inside, and covered with 6 to 8 in. of river gravel prior to pouring of the concrete slab; consequently—short of building on top of a hidden spring—under-slab conditions are dry.

Next, I question the need of waterproofing the slab if built as mentioned above. With 6 to 8 in. of gravel on top of grade and the slab above that, how can you make water come up to floor level or even the underside of the slab? I can't ever recall having seen water come through a concrete sidewalk. It is my belief that the wet condition of concrete slab floors often found in non-radiant heated structures is due only to surface condensation of inside airborne moisture on the cold slab. With heated floor slabs, as in radiant heated structures, that moisture problem is eliminated.

I have designed so many radiant type heating systems that I have lost count of them. They comprise residences, stores, garages, factory buildings, warehouses, offices, etc. Some of these have heating seasons behind them, some are in the process of installation. The difficulties experienced have been minor, due generally to the contractor's or workman's inexperience with radiant heating. However, that is a story too long for this letter.

I believe radiant heating has many advantages, and that time and first-hand experience will prove its value—ED. E. SCOTT.

"Impractical Tests" Handicap Welding

THE EDITOR—Arc welding has been of decisive importance to America. Arc welding did more than most other manufacturing processes in the producing of the tools of war during World War II. Arc welding has produced a record for reliability in billions of welds, made over many years, that is unmatched by any other manufacturing process—yet arc welding is being attacked in a way which is tremendously handicapping its application, and promises still more to interfere with its future use.

This attack is aimed not at the process, as such. It is obvious such tactics would fail. The attack consists in throwing suspicion on the process by writing into specifications expensive and impractical tests which have little to do with the excellence of the weld. Most of them have to do with infinitesimal variations of no possible importance, but of great cost. The attack has already eliminated the economic use in many proper applications. If continued, it will soon eliminate many others.

We see, for instance, the ruling that welds must be x-rayed, which increases the cost by several times —yet the commercially welded joint is always of greater strength than the parent metal and is tremendously stronger than any riveted joint, where x-raying never has been suggested.

We see riveted joints which are made tight by caulking. This process is accepted without question. The resulting undercut is enormous—yet a welding undercut that is infinitesimal is frequently made the reason for rejection of welds.

We see welds chipped out, rewelded, and welded vessels rejected because of trifling defects such as infinitesimal porosity either on the surface or beneath—yet parent metal in the same structure with defects much greater, and whose weakening effect would be tremendously more serious, is accepted without question.

We see welding electrode specifications being written which enormously increase the cost of production with no increase in either the reliability nor in the excellence of electrodes. Rivets have no such test to handicap them.

While welding electrode is tested in every conceivable and nonsensical way, no one suggests any test on a rivet—yet the riveted joint is always the weakest spot in any structure. This is never true of a full sized welded joint.

Much time and expense is used in testing electrode deposit to make sure it has great ductility and the weld is rejected if the ductility is low—yet riveted joints have no elongation and are accepted without question.

The contour of the deposit of a weld is a matter of very close inspection—yet no one examines the the contour of any rivet or the hole it only partially fills.

All insured vessels must have their welds x-rayed and any weld is rejected if any infinitesimal defect is found—yet no one x-rays a riveted joint nor rejects it because of the voids between the rivets and the rivet holes which are known to be always present.

Because of the higher elastic limit of the weld metal, there is no load that can be put on a welded structure in which the weld is of equal or greater section than the parent metal which can affect the weld in any possible way until great distortion of the rest of the structure has taken place. Such distortion would make that structure valueless for its intended purpose, yet all this testing and rejecting listed above is made mandatory in many welded structures, never in riveted structures.

Further instances of the same kind can be cited by the scores. The examples shown are sufficient for the author's purpose.

Welding over the years has done a more reliable job than the rivets it has replaced. That record is conclusive. The engineering profession, which relies so completely on welding in so many cases, must recognize and resist this studied attempt to eliminate the arc welding process. The attack has already eliminated the economic use of welding in many structures. The success of such an attack on this tremendously valuable method is neither good advertising for the engineering profession nor good ethics for those involved in the attack. It is time we dealt with reality.—J. F. LINCOLN, president, The Lincoln Electric Co.

HEAT PUMP HAS PROCESS USES

THE EDITOR—Referring to page 97 of the May HPAC, it is stated that the cost of a million Btu's with direct electric heating was 29c, in an example mentioned in a paper given at the Midwest Power Conference. This would mean an electric rate of approximately 1/10c per kwhr. Is this correct, or did the decimal place slip? — JOSEPH M. CHAMBLISS.

REPLY—We'll admit that the 1/10c rate looks strange, but in the paper on which this item was based, the authors said that electric energy from a hydroelectric development may be available at one mill per kwhr and that examples can be found where energy is offered for sale at such a price, particularly on a secondary basis. We probably should have mentioned in our item that such a rate is far from common; thanks for calling it to attention.—ED.

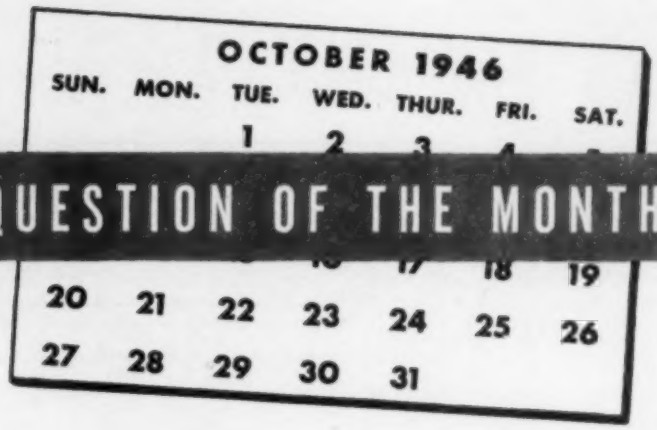
THREE-SHIFT SCHEDULE FOR ENGINEERS

THE EDITOR—Referring to the three-shift schedule for engineers published in the September HPAC, I would say that it is a good working schedule.

The engineers—including the chief—are at times on different shifts, which gives all men an opportunity to become familiar with the equipment under different loads and operating conditions.

The chief engineer is on duty at times, which keeps him familiar with operating practice and load conditions. The chief on certain days is on duty with an operating engineer, which is a help when checking, adjusting, and making repairs to the plant equipment.

The schedule as outlined seems fair from every standpoint.—W. H. WILSON, member of HPAC's board of consulting and contributing editors.



QUESTION OF THE MONTH

What Amount of Heat for Two Dry Kilns?

H.W., *a reader of HPAC, asked the following question, which was published in the September HPAC:*

"A plant making veneer crates and hampers for the fruit and vegetable trade has two dry kilns each 7 x 22 x 120 ft. Eight thousand wet crates are put through these per day. Each crate carries about 8 lb of water. Banks of steam coils at one end with powerful exhaust fans at the other furnish the present drying medium. No one knows the capacity of the fans, but they are extremely powerful.

"With the exception of the wire stitching department, this plant is shut down on Saturday. Because of this, they have to dry material during the week for this day's run. This adds to the cost and gives poorer work. These cannot lay wet because of mildew.

"This firm is interested in getting some auxiliary heat to enable them to operate the kilns on Saturday. It is my feeling that a direct fired oil heater would be the most economical. As they normally fire the boilers with mill waste, of which they do not have enough and have to add oil, I feel that they would be better off to use oil heat all of the time as the direct application would be more economical than burning it under the boilers, with the characteristic saw mill losses in between.

"I have been trying to locate manufacturers of units suitable for this job and perhaps you can help me locate some. One that I contacted claims that this load would take 6,400,000 Btu per hr. Another company states it would require 280,000 Btu per hr with electrical unit heaters. With this difference, it is very apparent that someone is "all wet."

"Can the necessary data as to the amount of heat required be supplied? It will certainly be appreciated."

The following is in answer to H. W.

THIS IS in reply to "H. W.," who wishes to know the heat input to a kiln for drying 8000 wood crates each said to have 8 lb of water.

No information is given as to whether all of the 8 lb of water is to be removed, but one assumes that 8 lb is the difference between the weight of the crate as it enters the drying tunnel and its weight in its commercially acceptable condition as it emerges.

The drying is accomplished in an air-swept tunnel 120 ft long and the air is said to be heated by steam coils at one end and withdrawn by fans at the other end. The cross section of the kiln is 154 sq ft, but no data are given as to the capacity of the exhaust fans and nothing is said about whether there is but one fan per kiln or whether there are several.

There is no information disclosed as to the steam pressure or as to the temperature of the entering and departing air. The heat input required to evaporate 8 × 8000 or 64,000 lb of water in 24 hr will be influenced profoundly by the air volume and air temperature.

The efficiency of the tunnel will be influenced profoundly by the intimacy of contact between the air and the wood crates. It is entirely possible, given adequate air volume and temperature, that the drying is accomplished within a length much less than the stated 120 ft. It is entirely possible that unless these matters of temperature and volume and intimacy of contact are controlled definitely, the wood may be dried so rapidly and to such an extent that cracks and damage occur.

The water evaporated from the wood must be discharged into the open air, and to carry it away in the form of steam (which may be invisible vapor) requires that the air inlets and outlets shall be controlled, with some attention given to the moisture content of the entering air.

To evaporate 1 lb of water from liquid to vapor at 100 F temperature, which is probably about all that normally is attained with the steam coil heating, approximately 1036 Btu will be required.

If the 154 sq ft cross section airway around the wood in the tunnel is 75 per cent occupied by the wood and if air velocity of 1000 fpm is maintained through the remaining area of about 38 sq ft, then about 38,000 cfm of air must be heated from, say, 70 deg

to the necessary temperature to carry away the moisture. 8000 crates at 8 lb of water each = 64,000 lb of water per 24 hr day, at 1036 Btu per lb, or (64,000 ÷ 24) × 1036 = 2,761,976 Btu per hr.

Suppose we assume that 38,000 cfm of air, or 2,280,000 cfh of air, is to be passed over the wood. The heat required to warm 1 cu ft of air 1 deg is 0.018 Btu. Then [2.761,976 ÷ (2,280,000 × 0.018)] = about 67.3 deg, the temperature difference that must be maintained between that of the air entering the coils and that of the air leaving the coils. If the air enters the kiln at 70 deg and leaves it at 70 deg, it must be warmed to about 137 deg.

If an oil burning warm air furnace is to be used for one of the kilns it must have a rating reasonably in excess of 2,761,976 Btu per hr and there should be room in the casing to permit passage of around 40,000 cfm of air.—S. L.

USE TANK OR TANKLESS TYPE OF WATER HEATER?

R. A., *a reader of HPAC, asked the following question about water heaters in the July issue:*

"I have been told that in hard water areas there is more likelihood of encountering trouble with a tankless type of water heater than there is with a tank type. It doesn't seem to me that there should be any particular difference between the two types on account of water hardness, but I'd be interested in learning of any experience on this point or having comments from other readers giving their ideas."

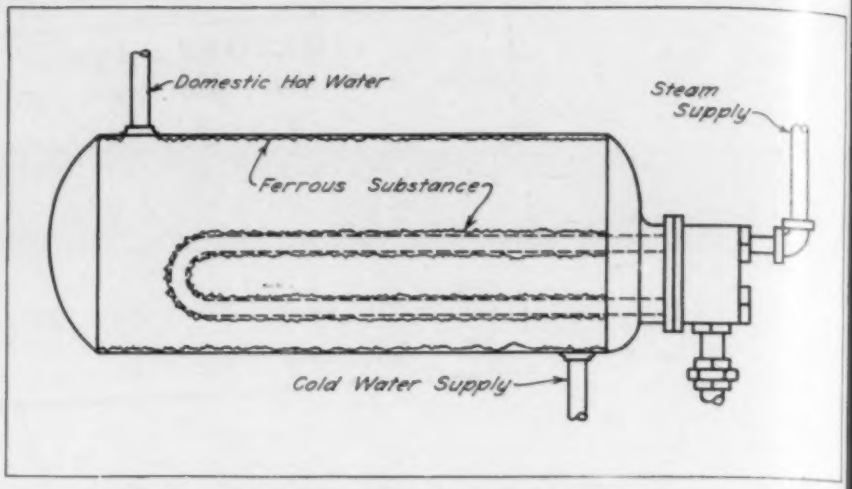
Several answers to R. A. were published in August. Following are some more comments, which have been received since that time:

In Boston, where the city water is of the soft type, trouble was encountered in a particular domestic hot water installation where, due to wartime restrictions, steel coils were used in a steel storage type water heater. Two weeks after installation the heated water temperature dropped from the required 180 F to 90 F. Upon observation of the coils and tank there was found on both a coating of an insulating substance later analyzed by our laboratory as a ferrous substance, caused by the chemical action of the water on the metal. Due to this accumulation, the heat transfer of the coils to the water was cut down to a minimum.

Although the ferrous substance was baked on under heating conditions it was found to be soluble in water when cooled.

It is my contention that a tankless type water heater would encounter less difficulty due to a seeming washing action caused by the greater velocity of the water traveling through the heater.

It is assumed that the same steam pressure would be used in both installations.—R. W. H.



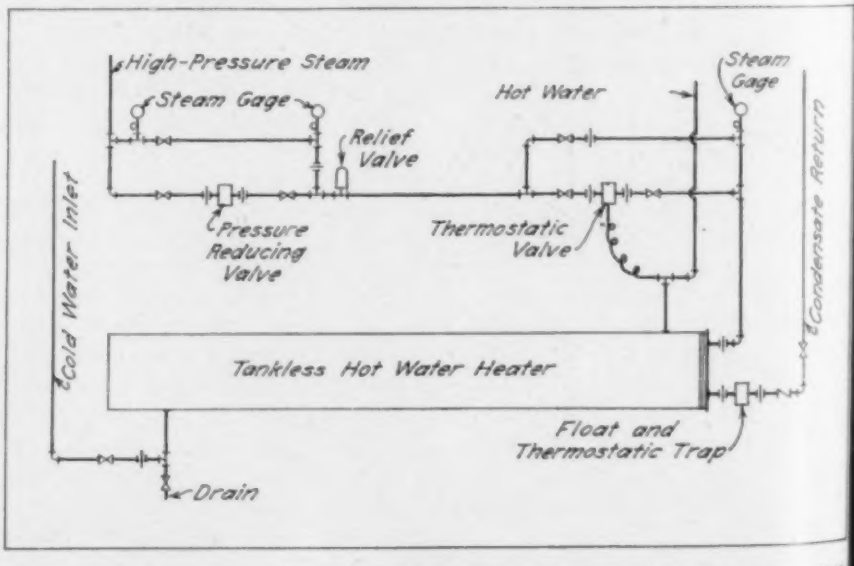
Sketch submitted by R. W. H.

In my opinion, I think R. A. will encounter a scale difficulty on either type of installation. I suggest that a water softener be installed and the scale problem will be solved. However, if a softener is not installed, and the same conditions prevail, you are going to have scaling condition on either installation. I would therefore say the difference on the tankless and tank type heater would be equal on scale accumulation.

As to installation, location, and capacities, each of these types of heater has its merits. For example, the tankless heater is capable of giving instantaneous hot water, and can be installed in a minimum amount of space, thereby leaving more room or added room for other equipment.

The tank type heater will give a reserve of hot water in relation to its capacity.—H. B. K.

Sketch—submitted by H. B. K.—of industrial installation of a tankless hot water heater showing schematic piping arrangement. Steam in coils and water on outside of coils in the jacket



HOW DESIGN SNOW MELTING COILS?

THIS IS IN reply to the request for data on snow melting coils in the Question of the Month section of the August HPAC.

Considerable research has been conducted on the question, and it has been found that the U. S. Weather Bureau will provide information on the average densities of snow falling in various sections of the United States. With these figures available the latent heat of fusion for snow falling in any specific area may be computed by comparing the density of the snow, for the section in question, directly with the latent heat of fusion for ice—which may be assumed to be 144 Btu per lb.

According to the book, Heat Transmission, by W. H. McAdams, in the 1942 edition, page 384, the density for ice at 32 F is 57.5 lb per cu ft. For example, assume the density of snow in a given section of the country to be 30.5 lb per cu ft at 32 F. The latent heat of fusion of this snow would be 76.5 Btu per lb. If the basis of design is to be made on a snowfall of 1 in. per hr, 30.5 divided by 12 or 2.54 lb of snow would have to be melted each hour. In other words, 194.2 Btu would be required of each square foot of surface to melt snow.

From the booklet, Wrought Iron for Radiant Heating, published by A. M. Byers Co., page 11, an additional quantity of 25 to 30 per cent of all other heat losses should be included for loss into the ground—so 194.2 divided by 0.75 or 260 Btu per hr per sq ft would be required to be delivered to the panel.

Other sources of information considered are:

1) Tables of Precipitation in the United States, by C. A. Schott, published in 1872 by the Smithsonian Institution were consulted, but only rainfall and melted snowfall were given in periods of months, seasons, and for years for each state and some neighboring foreign countries.

2) The Handbook of Snow Removal, by the Good Roads Machinery Co., gives a table published by the U. S. Department of Agriculture, Bureau of Public Roads, Division of Construction, in 1925 which lists the minimum and maximum average snowfall recorded over period of years in different sections of each state for each state.

If the above information needs further clarification, I will attempt to answer any questions that might arise.—R. R.

HOW INSTALL PIPING, PUMP ON WATER JOBS?

YOU ARE *invited to submit an answer to the following question from "A. S. R." for publication in these pages. Suitable answers will be paid for at regular rates, with additional payment for sketches. You are invited, too, to submit a question about heating, piping, or air conditioning for publication here.*

WHY IS IT better practice to take the branches off the side of the main instead of off the top in gravity hot water heating systems, and why is it recommended that the pump be placed on the supply main rather than the return main in forced hot water heating systems when the main is installed below the level of the boiler?—A. S. R.

Can Wastefulness Be Economical?

IT OFTEN has been said that where fuel is cheap it does not make much difference whether or not the steam boiler, steam engine, diesel engine, or electric motor is efficient—that the fuel doesn't cost much anyway and therefore the waste is insignificant.

That, however, is a fallacy that is worthy of careful thought.

For example, in the coal fields, where coal costs very little, it is evident that it is more economical to operate a single boiler with an efficiency of 80 per cent than to operate two boilers having the same initial cost at 40 per cent efficiency each. It would require two boilers and twice as much coal to do the work of a single boiler, kept clean, having an efficiency of 80 per cent. Not only would two boilers have to be purchased in the first place but they would require twice as much floor space, a building twice as large, additional piping, the cost of labor for shoveling the coal would be greater, taxes would be greater, depreciation greater, etc. The fact that the coal costs practically nothing is therefore no good reason why one can afford to be wasteful.

In the same way, an engine or electric generator of high efficiency will do more work than an engine or generator of low efficiency.

On the other hand there is such a thing as "too much efficiency." A machine that is highly efficient invariably costs more than one that is inefficient. Thus, if for $1,000,000 one could develop an engine that would produce one horsepower at no cost whatever for fuel, it would still be much better to buy a cheap wasteful engine because the interest alone on $1,000,000 at 5 per cent is $50,000 per year.

There is plenty of free, harnessable energy all around us that we can have for nothing if we want it, that is, if we can obtain the necessary machine for doing the harnessing for nothing. The wind, for instance, contains considerable power and "all that is necessary" to harness it is to build a windmill, put in generators, storage batteries, and so forth. The same is true of the tides and of sun power. However, the first cost of the equipment for doing this harnessing is so high that we usually find it more economical to purchase fuel and use machinery that has a lower first cost per horsepower developed.—W. F. SCHAPHORST.

Engineer Recalls a Boyhood Job on Farm, Cites Other Methods of Conveying Btu's

IN THIS regular feature, informal comment on heating, piping, and air conditioning matters is given by Samuel R. Lewis, consulting mechanical engineer, a member of HPAC's board of consulting and contributing editors. This month he discusses some of the methods used in conveying heat such as by a gas, a liquid, or solids.

TRANSFERRING HEAT

CONSTANTLY one is confronted with heat transfer problems in heating, piping, and air conditioning work. They are all diverting and some of them may be thought-provoking.

We all know about the radiant heat from the sun that comes through space that is apparently empty, but when entering the relatively microscopical thin layer of air around the world commences to do things. When these heat rays "see" the solid substances of earth and wood these solids become warm and we have vegetation, and when the rays strike water the water changes state from liquid to gas and we have clouds and rain. The sun's rays warm the rocks and the rocks transfer the heat to the air and the energy so transmitted makes the air move—and so we have winds. (One cannot forbear having at least some respect for our ancestors who, feeling the necessity for something to worship, selected the sun.)

"Boiled Brisket of Mammoth"

The ancient cooks used to make water containers of bark. They doubtless became tired of broiled and baked meats and vegetables and wanted to try boiling. So some pioneer dropped stones into the wooden water vessel and soon our ancestors were enjoying boiled onions and boiled brisket of mammoth wth horseradish sauce.

As a boy on a farm I remember a pile of old chunks of heavy metal that was treasured from year to year. There was also a heavy wood trough about as large as a big man's coffin. There came the day of the periodical butchering of fat hogs so that the smoked hams and bacon and sausage of blessed memory could be prepared.

The wood trough was filled with water from the old oaken bucket. A big fire was built out in the yard and the old chunks of metal were thrown on it and were heated. Then with metal hooks they were dragged out of the embers and were dropped into the water. The water reached a scalding temperature very quickly and was ready for sousing the carcass of the first hog. After this immersion the men scraped off the easily removed bristles. My job was to keep the fire going and to keep reheating the metal heat transfer devices, since with the aid of the neighboring farmers we would butcher a dozen or more hogs during that day.

My job later on was to keep alive the smoldering hickory fire in the wooden smokehouse, where the meat was cured.

Two Simple Procedures

In heat transfer it will be seen that there are two very simple procedures, one to bring the heat to the recipient, the other to bring the recipient to the heat. Thus, in blast furnaces for melting and purifying metal, the principal heat of combustion is developed within the refractory lined furnace by bringing hot air under pressure to the fuel. After changing the metal from a solid to a liquid that flows out of the bottom of the furnace, the products of combustion—in the form of gas—retain a great deal of heat. The gases then are forced through a heat conserver called a stove.

The blast furnace stove is a metal tank packed with refractory blocks around and between which the hot gases are forced by fans for a time so as to transfer to the blocks a considerable part of the otherwise wasted heat. Each blast furnace is surrounded by several of these stoves and the hot gases are delivered to the stoves successively and intermittently, since a blast furnace once blown in keeps running night and day. As soon as each stove becomes heated the gases are switched to the next one and the air supply for the blast furnace is drawn through the former gas passages and becomes exceedingly hot, this conservation of heat bringing about marked fuel economies.

In the processing of metal from ore to steel there is another important heat transfer. Normal atmosphere that must be drawn on for the air used in the blast furnace contains varying percentages of moisture. If this moisture in the form of invisible steam were not present we would have a hard time living. The moisture is of no value, however, when it comes to heating the vast quantities of air to the very high temperatures necessary in processing the low grade mate-

rials from which iron is separated.

Marked economies are possible of attainment by dehumidifying the air for combustion purposes in a blast furnace prior to sending it through the stove. This dehumidifying is often accomplished by cooling the air below its dew point with refrigeration, so that much of the moisture falls out of the air as liquid. Thus, to refrigerate air used for melting metals may seem strange to the uninitiated, but the scheme is in general use and is eminently successful.

A recently developed arrangement for transferring heat, borrowing from the stove analogy, permits heated refractory in the form of balls from the vessel in which the balls receive heat from liquids or gases, to fall through an orifice or trap like that in an hourglass, to another vessel in which the heat carried by the balls is transferred to other liquids or gases.

An example of this may be seen in the necessary cooling of sand used for forms in casting metals or plastics. It is economical and desirable to re-use the sand but it is necessary to remove from the sand the considerable heat that it acquired while receiving, and cooling to a solid state, the molten material that formed the casting. To store the hot sand in bins while it slowly cools to workable condition is not usually practicable. In this case the air in great quantities is brought to the sand after the manner of the blast furnace stove, but both the sand and the air have to be agitated and mixed in order to accomplish the necessary rapid transfer.

Conclusions can be drawn to suggest that while in many industrial processes we carry the heat by a gas such as steam, by a liquid such as water, and by a combination of gas and liquid as in refrigeration, the possibilities of heat transportation by solids may not have been entirely exhausted.

Preventing Tanks from Floating

THE EDITOR—Samuel R. Lewis writes in the September HPAC about the flotation of a buried steel tank as if there were some mystery or uncertainty involved in overcoming this engineering problem. Actually, the answer was given some years ago by a gentleman from Greece named Archimedes, and his statement has withstood the test of time as unchallenged as the geometry of his fellow countryman, Euclid.

A body wholly or partially immersed in water is buoyed upward with a force equal to the weight of the displaced water. Despite this familiar law of hydraulics, Mr. Lewis says of a steel tank that weighs 12,000 lb, "the empty tank weighs in water 10,500 lb." If any object possessed weight in water it would not present a problem in flotation. Those objects that possess weight in water do not float—they sink. What should be said is that the *net* buoyant force exerted upward on the tank is the difference between the weight of the displaced water and the weight of the tank (in air). And that is the only force that must be compensated for in order to keep the tank underground. The cross section and head of water in no way affect the forces involved, except for the antibuoyant effect of the overburden.

The designer usually seeks to protect against water in the tank excavation; total flood is seldom a consideration for when flood strikes, there arise problems far more serious than buried tanks. Against water in the excavation, concrete placed above a tank, as at the surface, is much more effective than concrete at the bottom, for of course concrete below a tank would be buoyed up by the same water that tends to float the tank.

Civil engineers compute that earth above the tank, encompassed within the volume determined by a 45 deg upward slope starting from the tank perimeter at its center plane, is effective against buoyancy. The writer had this fact verified in a most convincing manner. During excavation for a fuel oil tank, water was encountered at 4 ft below surface, making it necessary to pump while going down the remaining distance to a total of 8 ft. Overnight, when the pump did not run, the water accumulated to a level 4 ft below grade. When the excavation was completed, water being pumped fast enough to keep it dry, the tank was set into place, immediately filled with fuel oil, and earth backfilled around the tank. The tank diameter being 5 ft, there was 3 ft of backfill above the tank. The remainder of the oil burner installation was not completed for several months, during which time the backfilled earth settled firmly into place and soon resumed its normal appearance. After the burner was placed in operation some months later, the level of fuel was allowed to drop to two-thirds empty before being refilled. During this time heavy rains fell, yet there was not the slightest disturbance of the earth above the tank. The backfilled earth had so firmly knit with the surrounding earth as to secure the tank in place.

There may be conditions when the knitting of the earth cannot be expected, as in sandy soil. Then of course there is no recourse but to place enough concrete above the tank to overcome buoyancy. Or again, even assuming normal soil conditions, there must be sufficient time lapse between filling the tank originally and withdrawing its contents to allow the earth to become packed.—KALMAN STEINER, C. Hoffberger Co.

SHERWOOD NAMED DEAN AT MIT

Thomas K. Sherwood has been appointed dean of the school of engineering at Massachusetts Institute of Technology. He has been deputy dean of engineering since last February, as well as professor of chemical engineering.

CONDENSING PRESSURES for Air Conditioning

Andrew P. Boehmer Develops Method of Analyzing Operating Costs of "Freon-12" Condensing Units

THAT THE CURVE of economic condensing pressures for "Freon-12" condensing units shown as Fig. 3 in the author's article last month (and reproduced on page 99 this month as a "data sheet") may be used to choose economic head pressures under actual operating conditions, may be shown by using condensing unit operation figures as published in manufacturers' catalogs. Units operating at air conditioning back pressures, with assumed water and electric rates, will be used for comparison.

Catalog Data Analyzed

Water consumption given in catalogs is normally expressed in gallons per hour or gallons per minute. Converting the assumed rate of 50 cents per 1000 cu ft to a gallon basis, the cost per gallon is found to be $50 \div (1000 \times 7.481$ gal per cu ft) $= 0.00668$, or 6.68 cents per 1000 gal.

Assuming an electric cost of 1.5 cents per kwhr, the value of $L^* = (1.5 \times 1000)/50 = 30$. The economic condensing pressure is found by using the curve in the following manner:

At the intersection of the entering water temperature line, (assumed as 75 F), and the value of $L = 30$, the economic condensing pressure of 125 psi gage is found. From the manufacturer's capacity data for the Model "A" condensing unit (as an example) it is found that operating under a 125 psi condensing pressure, the electrical energy is given as 9.87 kwhr per hr at a 40 F evaporating temperature. The water consumption under these conditions is given as 700 gph. The total cost of full load operation for 1 hr becomes:

$$C = 9.87\ (1.5) + \frac{700(6.68)}{1000}$$

$$= 19.5 \text{ cents per hr}$$

The capacity of this unit operating at a 40 F evaporating temperature and a 125 psi gage head pressure is 133,500 Btu per hr. The minimum cost per hour per ton is

$$C = 19.5 \times \frac{12{,}000}{133{,}500}$$

$$= 1.75 \text{ cents per hr per ton}$$

Using different manufacturers' figures to illustrate the variation in cost with the selection of various condensing pressures, the values of cost vs. condensing pressures are plotted in Fig. 5. This figure also contains the theoretical curve to permit comparison with the published results. As manufacturers' ratings are not intended to be closer than 2 per cent, the minimum points on the curves are consistent with those obtained theoretically.

Fig. 6 is presented to show the theoretical and actual curves at a condenser inlet water temperature of 70 F rather than 75 F, with all other factors constant. It may be noted that the theoretical and actual curves under the new conditions are consistent in form, with the minimum cost 5 deg lower.

Selection Based on Temperature Difference Through the Condenser

It is not necessary to take into account condenser surface or scale factor if selection of operating conditions for a specific value of L is based on discharge water temperature rather than on condensing pressure.

Table 1, incorporating values determined by the use of Figs. 2 and 3 published last month, shows that the most economical condensing temperature for $L = 30$ is a constant value greater than the inlet water temperature to the condenser.

*L is the electric rate in cents per kwhr divided by the water cost in cents per cu ft.

IT IS POSSIBLE to determine the operating conditions of refrigeration condensing units of from 10 to 60 hp to give maximum operating economy by selecting condensing conditions of the unit which will result in the minimum total cost of electricity for the compressor motor and water for condensing. The condensing pressure for air conditioning installations may be established when the electric rate, water cost, and the temperature of the water supply to the condenser are known. The condensing water discharge temperature is the best criterion of economical operation, as this temperature is relatively independent of the operation of the condenser. Maximum economy of operation is maintained with varying condenser water supply temperatures if the quantity of water is varied to maintain a constant temperature difference through the condenser. . . . The author is assistant professor of M. E. at the University of Rochester.

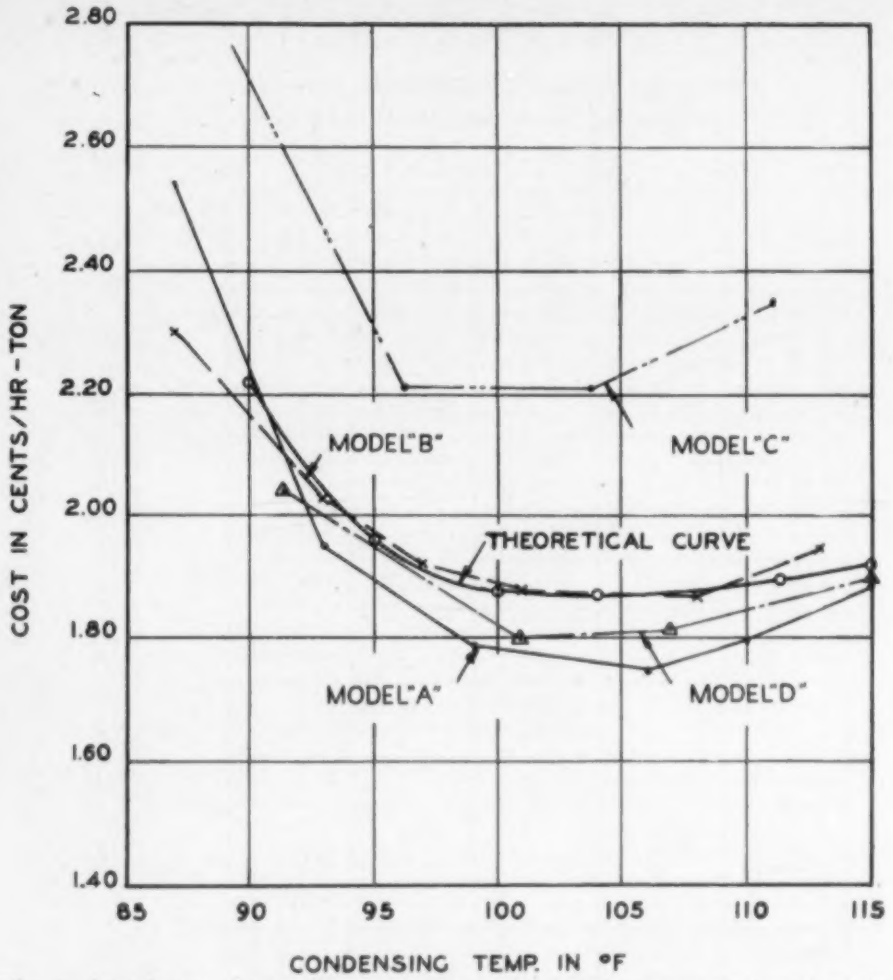


Fig. 5—Actual cost of operating condensing units, based on manufacturers' catalog data, with supply water temperature of 75 F. The model numbers shown are fictitious

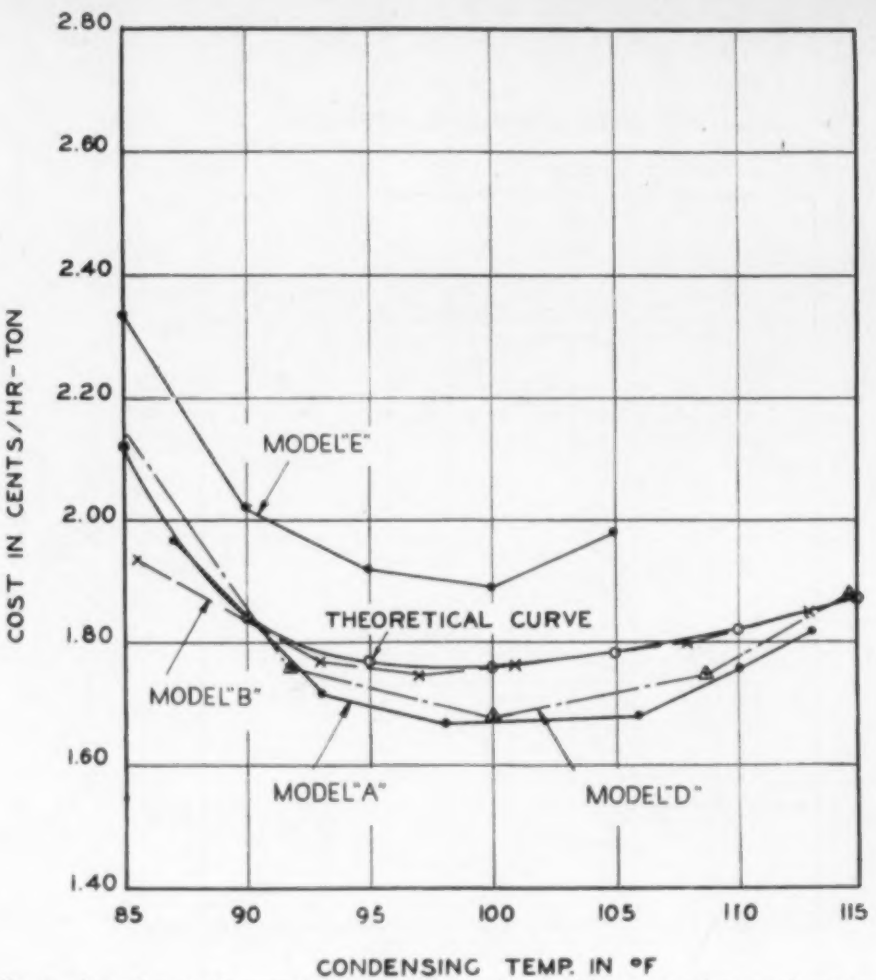


Fig. 6—Actual cost of operating condensing units, based on manufacturers' catalog data, with supply water temperature of 70 F. The model numbers shown are fictitious

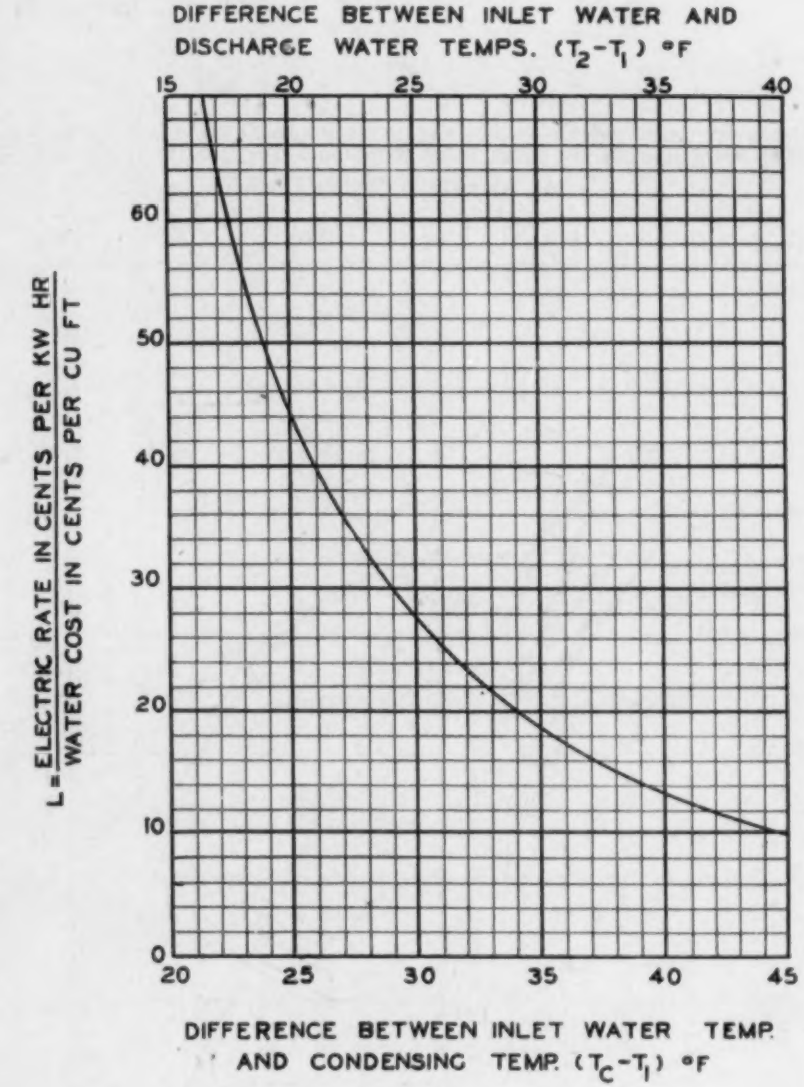

DIFFERENCE BETWEEN INLET WATER AND DISCHARGE WATER TEMPS. (T_2-T_1) °F
15 20 25 30 35 40
60 50 40 30 20 10 0
$L = \frac{\text{ELECTRIC RATE IN CENTS PER KW HR}}{\text{WATER COST IN CENTS PER CU FT}}$
20 25 30 35 40 45
DIFFERENCE BETWEEN INLET WATER TEMP. AND CONDENSING TEMP. (T_C-T_1) °F

Fig. 7—Economic condensing temperatures based on inlet water temperatures for "Freon-12" condensing units operating at air conditioning evaporating temperatures

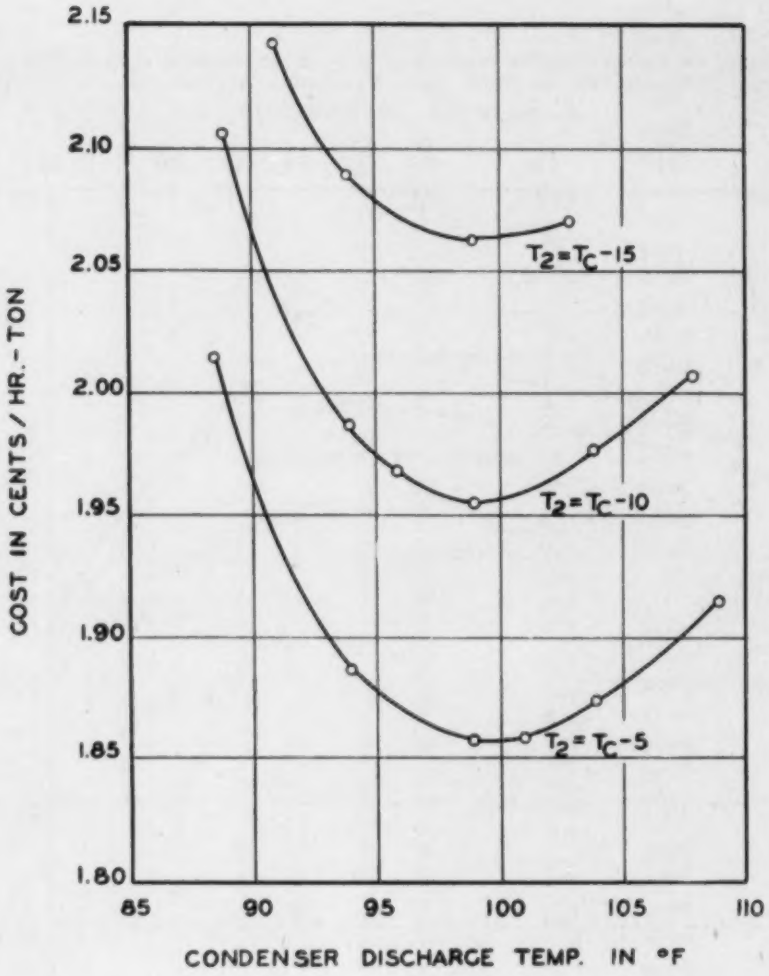


Fig. 8—Operating cost analysis based on varying condenser operation

Table 1—**Most economical condensing pressure for L=30 is a constant value greater than the initial water temperature to the condenser.**

Inlet Water Temp. (t_1)	Economic Cond. Pres.	Economic Cond. Temp. (t_c)	(t_c-t_1)
60	112	89	29
65	121	94	29
70	130	99	29
75	141	104	29
80	149	109	29
85	158	114	29

For other values of L, other values of temperature differences are found. These are plotted on Fig. 7.

To illustrate the use of this curve, the assumption will again be made that the electric rate is 1.5 cents per kwhr, the water rate is 50 cents per 1000 cu ft, and the evaporating temperature is 40 F. Therefore, $L = (1.5 \times 1000)/50 = 30$.

From Fig. 7, $t_2 - t_1 = 24$ F; and if $t_c = t_2 + 5$, then $t_c = t_1 + 24 + 5 = 75 + 29 = 104$ F.

From Fig. 2, published last month, $P_c = 139$ psi absolute, or 124 psi gage.

For economical operation, then, it is desirable to measure the temperature of the discharge water from the condensing unit as well as the condensing pressure. This becomes a possible check upon the presence of noncondensables, and also an indication of the need of condenser cleaning.

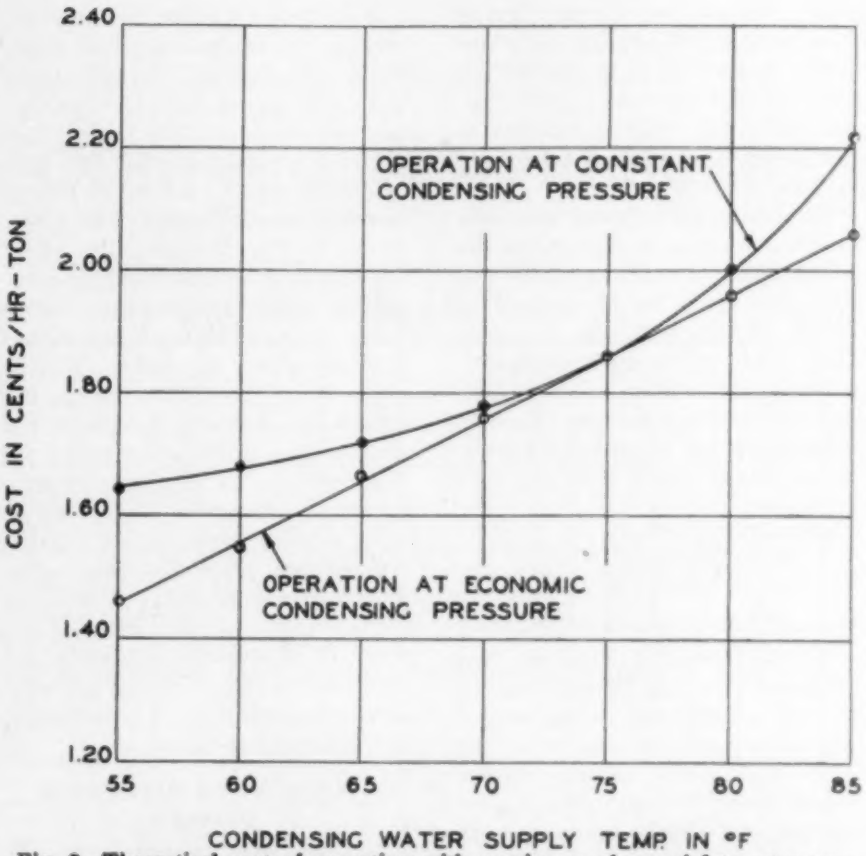


Fig. 9—Theoretical cost of operating with varying condenser inlet water temperature using constant condensing pressure and economic condensing pressure

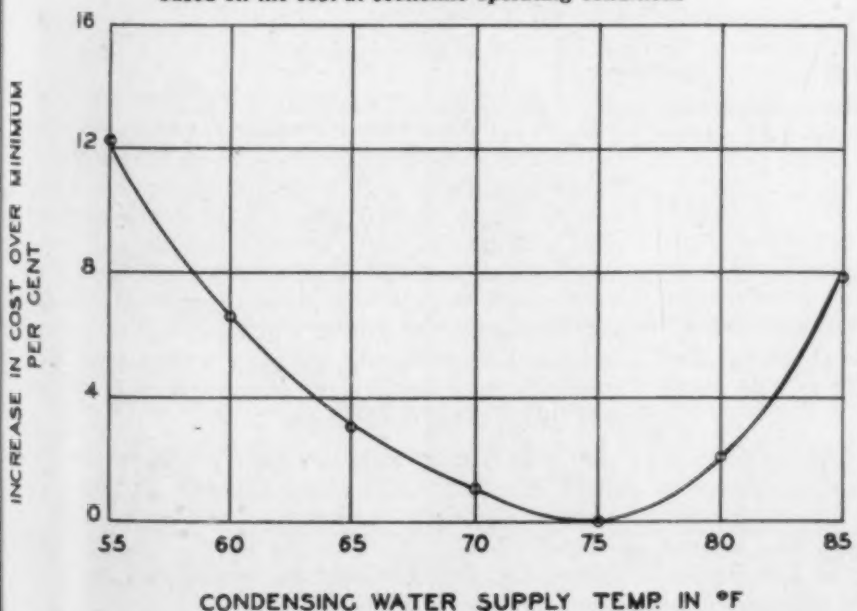
Variation in Operating Cost With Varying Condenser Operation

To clarify the premise that condenser operation does not affect the selection of the economic condensing water discharge temperature, and to demonstrate the effect on cost in using small or unclean condenser surfaces, Fig. 8 was plotted. Curves are shown which demonstrate the fact that as the difference between the discharge water temperature and the condensing temperature increases, the cost of operation of the unit per ton of refrigeration increases. Increasing the temperature difference between the water out of the condenser, t_2, and the condensing temperature, t_c, is equivalent to using condensers which are inadequate as outlined above. It may be noted, however, that the minimum of every cost curve is at a discharge temperature of 99 F.

Effect on Economic Head Pressures of Varying Inlet Water Temperature to Condenser

Fig. 3 (published last month, and reproduced as a "data sheet" this month) shows that the economic head pressure is affected to a considerable degree by the entering water temperature. This would indicate that an adjustment of water discharge temperature, which might normally be used throughout certain seasons of the

Fig. 10—Variation in operating cost as a percentage based on the cost at economic operating conditions



year, should be varied during other seasons when entering water temperatures may be higher or lower than those used in the original selection. This condition is frequently met in year 'round operation.

To make a study of this, the original example is changed to the extent that the entering water will be assumed to be 65 instead of 75 F. What variation in operating cost will be encountered?

First, the water valve adjustment will be assumed to be set to maintain a 139 psi head pressure. Under these conditions, the cost becomes:

$$C_t = 1.5(1.19(2.69)^{0.48} - 1) + \frac{0.05(146 + 55.6(2.69)^{0.48})}{104 - 5 - 65}$$

$C_t = 1.37 + 0.35 = 1.72$ cents per hr per ton

When compared with the cost of operation using 75 deg water, a saving is indicated. However, if Fig. 3 is used to determine the most economical setting of the water valve, the best operating economy will result when a head pressure of 121 psi absolute is maintained. Under these conditions, $r = 121/51.7 = 2.34$, and $C_t = 1.19 + 0.48 = 1.67$ cents per hr per ton. This is an additional saving of 3 per cent.

Fig. 9 was plotted to show the saving in readjusting for economic condensing temperatures with varying condenser water supply temperatures. The design condensing temperature chosen as a reference was based on 75 F condensing water supply. The upper curve in Fig. 9 shows the effect on cost of operation when the entering water temperature varies while the condensing temperature is maintained constant. This is the usual condition occurring when the water supplied to the condensing unit is controlled by the setting of a pressure or temperature operated water valve. The lower curve shows the reduced cost when the head pressure is properly changed with the temperature of the inlet water. Fig. 10 shows more clearly the economies involved as percentages of operating cost at economic condensing conditions.

Water Valve Adjustment Desirable

Adjustment of the water valve at different seasons during operation of the system is seen to be very desirable. However, one difficulty encountered is that this adjustment should be made by an experienced refrigeration mechanic.

For conditions where variations in condenser supply water temperature occur, it would be desirable to use a water valve designed to operate on a constant temperature difference through the condenser rather than at a constant condensing temperature. With this type of water valve, a setting made for one set of conditions, as regards inlet and discharge water temperature through the condenser, would not have to be changed, regardless of the variation of inlet water temperature. No valve of this type has yet come to the attention of this author, but the design well warrants an investigation by manufacturers of this type of equipment.

[*Acknowledgments* — The author wishes to acknowledge assistance from Professor C. O. Mackey of Cornell University and R. E. Cherne, consulting engineer, Rochester, N. Y., for their aid in the development and presentation of this material.]

[The first part of this article, including Figs. 1-4, was published in the September HPAC. Fig. 3 from the September installment appears again this month as a "data sheet."]

New Federal Specification on Insulating Cements Now Available

Some of the requirements of the new Federal specifications on insulating cements are (1) mineral wool cements shall withstand 1500 F (tested for 96 hr without physical change), (2) a finally applied coating shall not exceed 27 lb per cu ft in density, (3) 100 lb of material shall cover at least 45 sq ft to a thickness of 1 in., (4) shrinkage shall not exceed 20 per cent by volume on drying, (5) the thermal conductivity shall not exceed 0.70 Btu at 200 F nor 1.05 Btu at 800 F, and (6) the loss in weight after 6 hr at 1500 F shall not be greater than 10 per cent.

This Federal specification (HH-C-168) was developed by the specifications committee of the Industrial Mineral Wool Institute and the heat insulating materials committee of the Federal Specification Executive Committee (Procurement) for the guidance of government buyers procuring insulating material for use on odd shaped fittings and surfaces with many recesses and protrusions.

While all well known brands of mineral wool cements more than comply with this specification, industrial users may find it useful in considering newly-developed products. Copies may be obtained for 5c each from the Superintendent of Documents, Washington 25, D. C.

American Edition of French Dictionary Published

A handy volume, issued for the use of translators, librarians, and students of many technical subjects, will also be of great help to engineers, chemists, industrial technicians, and scientists engaged in industrial and scientific research who wish to keep up with the new developments in the technical literature of French speaking countries.

The dictionary was compiled by Francis Gusset to help the technical man in reading French publications. It contains both English-French and French-English definitions, and in addition to giving the definitions of many English words, also defines many commonly used expressions and phrases such as air leakage, length of pipe, and measurement of air flow. Under words such as pipe and pressure, the various types are listed with the French equivalents. This arrangement will prove handy to many who prefer, for instance, to have the 37 listed terms involving the word pipe in one place in the book.

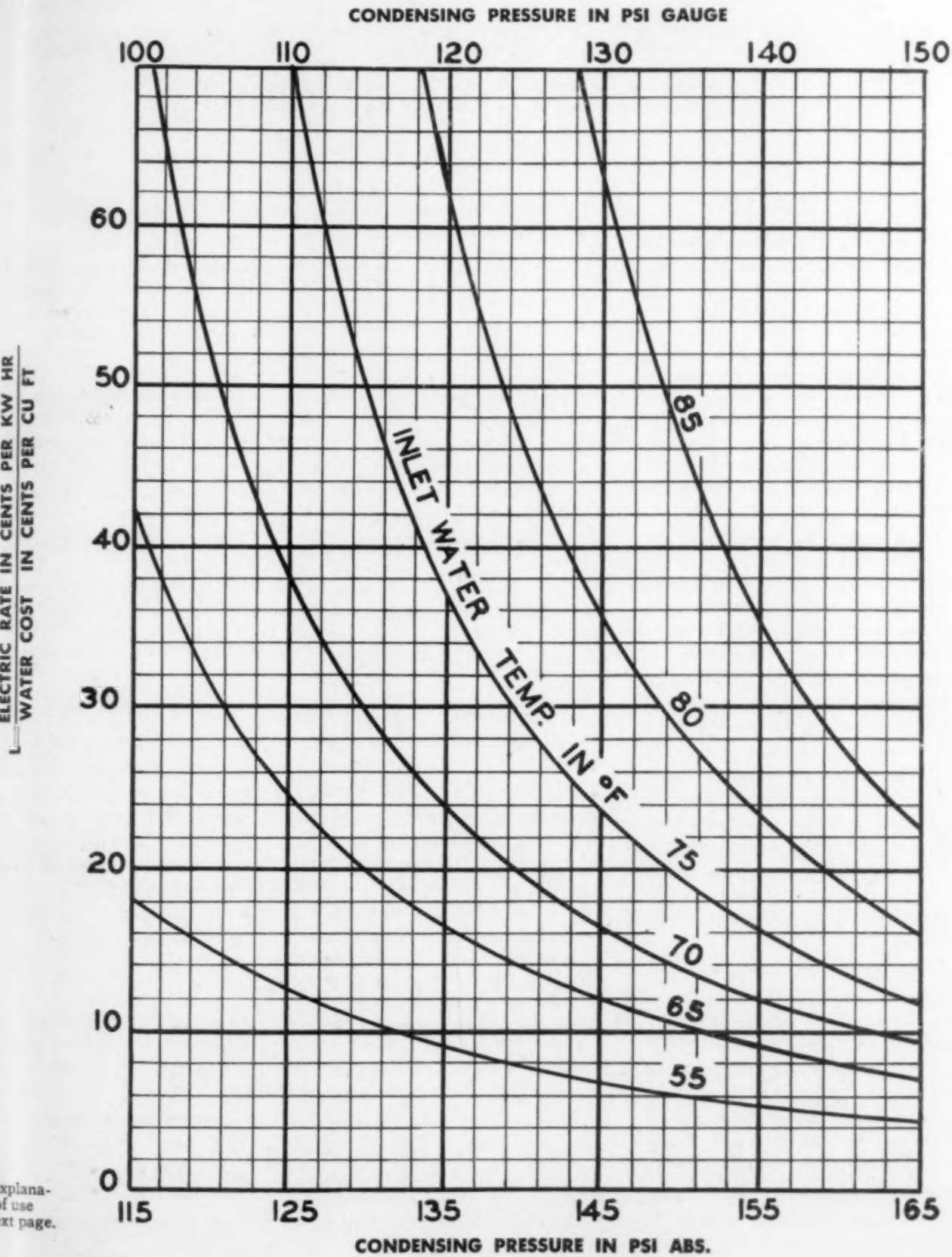
This 590 page, 5 x 6½ in., clothbound dictionary includes the words and terms common to metallurgy, mining, electricity, chemistry, mechanics, and various sciences. It is published by the Chemical Publishing Co., Inc., 26 Court St., Brooklyn 2, N. Y. The price per copy is $5.00.

DATA SHEET

By ANDREW P. BOEHMER, Assistant Professor of Mechanical Engineering, University of Rochester

ECONOMICAL CONDENSING PRESSURES

Economic condensing pressures for "Freon-12" condensing units operating at air conditioning evaporating temperatures



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SELECTING ECONOMICAL CONDENSING PRESSURES FOR AIR CONDITIONING

ANDREW P. BOEHMER points out (in his article published in two parts in the September and October 1946 issues of Heating, Piping & Air Conditioning) that it is possible to determine the operating conditions of refrigeration condensing units of from 10 to 60 hp to give maximum operating economy by selecting condensing conditions of the unit which will result in the minimum total cost of electricity for the compressor motor and water for condensing.

The condensing pressure for air conditioning installations may be established when the electric rate, water cost, and the temperature of the water supply to the condenser are known. The condensing water discharge temperature is the best criterion of economical operation, as this temperature is relatively independent of the operation of the condenser. Maximum economy of operation is maintained with varying condenser water supply temperatures if the quantity of water is varied to maintain a constant temperature difference through the condenser.

The curves shown on the preceding page make the selection of an economical condensing pressure for any particular value of L, at the evaporating temperature shown, a simple matter. (These curves were shown as Fig. 3 in the first part of Professor Boehmer's article in the September HPAC).

The data in this figure for establishing condensing pressures were based on discharge water temperatures assuming commercial scale factors when selecting condenser surface—that is, by assuming heat transfer based on slightly scaled tubes, and with sufficient condenser surface to reduce condensing temperatures to within 5 F of the temperature of the water leaving the condenser. Even though the condition of the condenser is not known, the most economical condition of operation may be determined by use of the discharge water temperature rather than the condensing pressure.

The latter, however, may be considered as a criterion for most installations of standard manufacturers' equipment in the sizes considered.

To demonstrate use of the curves, a sample problem is considered.

Assume that a 10 ton "Freon" refrigeration unit operating at air conditioning back pressure is in a locality where the electric cost is 1.5 cents per kwhr and the water cost is 50 cents per 1000 cu ft. Water inlet to the condensing unit is assumed to be 75 F. Under these conditions,

$$W = \frac{50}{1000} = 0.05 \text{ cents per cu ft}$$

$$L = \frac{1.5}{0.05} = 30$$

From the curves, the correct operating head pressure is found to be 139 psia, or 124 psig. The pressure P_s at air conditioning coil evaporating temperatures is approximately 51.7 psia. Then,

$$r = \frac{P_c}{P_s} = \frac{139}{51.7} = 2.69$$

The actual minimum cost of operation may be determined by using the following equation:

$$C_t = E\,(1.19r^{0.49} - 1.00) + \frac{W\,(146 + 55.6r^{0.49})}{t_c - 5 - t_1}$$

Substituting in this equation:

$$C_t = 1.5\,[1.19\,(2.69)^{0.49} - 1] + \frac{0.05\,[146 + 55.6\,(2.69)^{0.49}]}{(104 - 5 - 75)}$$

$C_t = 1.37 + 0.49 = 1.86$ cents per hr per ton

This gives an operating cost of 18.6 cents per hr for 10 tons of refrigeration under the conditions assumed. The division of cost shows 13.7 cents for electrical energy and 4.9 cents for condensing water.

Symbols Used

C_t = total operating cost, cents per hr per ton;

E = electric rate, cents per kwhr;

L = electric rate, cents per kwhr ÷ water rate, cents per cu ft;

P_c = condensing pressure, lb per sq in. absolute;

P_s = suction pressure, lb per sq in. absolute;

r = ratio of condensing pressure to suction pressure, P_c/P_s, lb per sq in. absolute;

t_c = condensing temperature, F;

t_1 = water temperature entering condenser, F;

W = water rate, cents per cu ft.

Heating, Piping & Air Conditioning

AMERICAN SOCIETY of HEATING and VENTILATING ENGINEERS

Journal Section

Psychrometric Instrumentation

A review of the accuracy of psychrometric instruments and their application

Introduction*

Since the working substance of the air conditioning engineer is oist air, studies concerned with the instruments and methods used the determination of the properties of moist air rightly find a minent place in the program of the Committee on Research.

In January 1945 the Society sponsored the formation of the ternational Joint Committee on Psychrometric Data. This Com-ittee, in which 16 American, British, and Canadian organiza-ns are participating, is working toward the acceptance, both tionally and internationally, of correct, adequate and uniform ts on the properties of air-vapor mixtures.

The Committee on Research, in cooperation with the Department Chemical Engineering, University of Toronto, Ontario, Canada, has for the past 18 months been investigating the problem of the determination of the true dewpoint of air-vapor mixtures.

To round out the program it seemed advisable to bring before the ASHVE *membership the latest available information on the methods used to determine the properties of moist air, the accuracy of the various types of psychrometric instruments available, and the precautions to be taken in their use.*

Therefore, it was arranged that L. G. Seigel, Case School of Applied Science, should work with the staff of the Laboratory to prepare this report. Discussion by members and others experienced in the field is invited as a means toward increasing the sum of our knowledge of this important branch of air conditioning.

Purpose of Psychrometry

THE purpose of psychrometry is determine the properties of oist air from which information eeded in the solution of problems curring in drying or air condi-oning processes can be obtained. herefore special instruments are ed which have come to be classi-d as psychrometers. Though the rm *psychrometer* properly applies ly to wet and dry bulb instru-ents, (9) (13)[1] this report will al with all methods and instru-ents used in any way to deter-ine the properties of moist air.

The properties of moist air hich are of interest to the air con-tioning engineer include dry lb temperature, wet bulb tem-rature, dewpoint temperature, per cent saturation or relative humidity, humidity ratio or absolute humidity, enthalpy, partial pressures of water vapor and air, and total or barometric pressure. Some of these properties, such as dry or wet bulb temperatures or barometric pressure, may be determined directly by relatively simple instruments. Others, such as enthalpy or partial pressures, cannot be determined directly by any instrument. However, all of these properties are so interrelated that if the barometric pressure and any other two properties are known, all of the remaining properties may be determined, either by calculation or from convenient tables or charts.

As just mentioned, barometric pressure is one of the properties essential for the solution of any psychrometric problem. However, since it is relatively uniform in any given locality, it is usually assumed to be constant. On the American continent psychrometric tables and charts are usually based on a barometric pressure of 29.921 in. Hg, and these are sufficiently accurate for most sections of the country. For locations having unusual elevation, or for very precise work, corrections must be made.

The dry bulb temperature may readily be determined by any one of a number of methods, and because of this it is almost invariably one of the two properties used. This report deals chiefly with those instruments which are used to determine one other property of moist air, which, when combined with barometric pressure and dry bulb temperature, defines a particular set of conditions. These instruments may also include means

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[1] Numerals in parentheses refer to Bibliography.

for determining the dry bulb temperature.

Comparison of Psychrometric Instruments

Table 1 lists all types of instruments available at the present time for determining any of the properties of moist air other than dry bulb temperature and barometric pressure. The accuracy indicated for each instrument is based on the assumption that proper correction is made for barometric pressure.

The Wet Bulb Method

The wet bulb method is most widely used today to determine psychrometric properties of air. It is capable of a good degree of accuracy when used with care, and it is especially valuable because the instruments used are portable and, in general, adaptable to practically all types of work. Unlike dewpoint instruments, wet bulb instruments require a relatively high air velocity to give accurate readings. This is so because an accurate wet bulb reading is considered to be one that agrees with the temperature of adiabatic saturation for the mixture under consideration; in order to bring about this agreement a velocity of about 1000 fpm must be maintained across the instrument. Actually, the observed wet bulb temperature may be above, below, or equal to the true temperature of adiabatic saturation depending on the conditions under which the measurement is made (6); the only one considered correct for psychrometric work, however, is that which is equal.

It will be evident that if the equality of the wet bulb temperature and the temperature of adiabatic saturation is to be obtained in practice, all factors which affect this agreement must be thoroughly understood. The most important of these factors are radiation and air velocity.

Table 1—Classification of Humidity Instruments

Type of Instrument	Remarks	Properties Indicated
I. Wet Bulb		
(a) Aspiration	Instrument errors less than 1 per cent. Easy to use and read. Lacks portability and general adaptability.	Dry and Wet Bulb Temperature
(b) Sling	Errors less than 2 per cent when used by skilled operator under proper conditions. Under ordinary circumstances, errors not greater than 3 per cent may be expected. Instrument is portable, inexpensive and well adapted to practically all types of work.	
(c) Stationary	Errors of about 10 per cent relative humidity may be expected. Instrument always reads high and error is dependent upon air movement. Not recommended except to give approximate relative results.	
II. Hygroscopic	Hygroscopic materials used include animal membranes, hair, wood in several forms, and horn. The best material for any particular application will depend upon the temperatures and relative humidities to be encountered. Any of these materials may be expected to produce relatively accurate results within certain ranges, and all will be inaccurate if their proper ranges are exceeded. Errors may range from 2 to 30 per cent.	Per Cent Saturation or Relative Humidity
III. Dewpoint	Most direct method. Under proper conditions errors may be less than 1 per cent but at high humidities or low temperatures the errors may be 5 per cent or more. Instruments lack portability, adaptability and require skilled operator.	Dewpoint Temperature
IV. Chemical	By use of precise methods of measurement humidity may be determined with error of about 0.1 per cent. Ordinary methods have errors between 2 and 3 per cent. Not an instrument but a laboratory apparatus.	Humidity Ratio or Absolute Humidity
V. Electrical Type		
(a) Thermal Conductivity	Errors less than 0.1 per cent claimed in limited range of operation. Still in development stage; not much information available at this time.	Humidity Ratio or Absolute Humidity
(b) Electrolytic	Range 10 per cent to 100 per cent R.H. for temperatures from +30 to —60 deg C. Calibration variation may be within 3 per cent R.H. for several months. Special application for radio-sonde work.	Per Cent Saturation or Relative Humidity

Note: Percentage errors indicated in table refer to per cent relative humidity.

Under ordinary conditions an unshielded wet bulb, agreement within 1 per cent of the bulb depression will be obtained the air velocity across the bulb greater than 600 fpm. However, the instrument is surrounded objects which are at a much high temperature than the wet bu such as the walls of a furnace, best procedure is to shield the th mometers so as to eliminate radiation effect. When this is don the wet bulb reading will be le than the temperature of adiaba saturation, and corrections d pending on air velocity may necessary for precise results. T deviation in this case may amou to about 3 per cent of the wet bu depression at an air velocity 1000 fpm (6).

For a complete discussion of t effects of air velocity and radiati on wet bulb temperature, refe ence should be made to the work Mackey (14) from which the fo lowing excerpt is taken.

"A wet bulb thermometer in relati stagnant air (velocity of 20 fpm) and co pletely shielded from radiation may shown to read a temperature that is abo 17 per cent of the wet bulb depression lo than the temperature of adiabatic satu tion; due to the effects of radiation, ho ever, a wet bulb thermometer that is s shielded and *sees* surfaces at the dry bu temperature will read a temperature stagnant air that is from 10 to 20 per ce of the wet bulb depression greater than t temperature of adiabatic saturation.

"If a wet bulb thermometer unshield from radiation is to read a temperatu equal to that of adiabatic saturation, f mixtures of water vapor and air, the velo ity of the air past the bulb must be be tween 500 and 1000 fpm. Since the sli psychrometer is usually whirled at such rate that the peripheral speed of the w bulb is about 1000 fpm, the temperatu read with this instrument differs from t temperature of adiabatic saturation by le than one per cent of the wet bulb depre sion and may be used as the temperature adiabatic saturation with negligible error

In addition to air velocity an radiation other practical considera tions must not be neglected. The effect cannot be expressed terms of per cent error, since the are not related in any way to th theory of the wet bulb thermom eter. They are, rather, practica problems encountered in the use the wet bulb method, but the must be dealt with, or eliminated if accurate results are to be ob tained.

The first of these is the length the wick used for the wet bul

ermometer. Often this question st be decided by the conditions der which the measurements e made, but wherever possible, wick should not exceed 2 in. in gth. A wick of this length is sier to maintain and is more re- ble than a wick of greater gth, especially when the water r wick is not near the wet bulb mperature. In no case, however, ould the wick be so short that e entire bulb is not covered; herwise too high a reading will sult. Theoretically a stem emer- nce correction should be applied the thermometer reading for e part of the stem which extends ove the wick. This correction is dinarily so small that it will be yond the accuracy of most ther- ometers and may safely be neg- cted.

Another factor to be considered the condition of the wick and e amount and temperature of the ater supplied to it. The wick ould be clean at all times, be- use the presence of impurities ay cause evaporation or diffu- on errors that will seriously af- ct the reading. Distilled water ould always be used and, wher- er possible, it should be main- ined at a temperature near the et bulb temperature. No more ater should be supplied than is quired to saturate the air around e bulb and produce the wet bulb ading. It is difficult to maintain e correct quantity and tempera- re of the water; it is usually cessary, therefore, to supply too uch water at a temperature mewhat different from the wet lb temperature. This may result serious errors if sufficient time d care are not taken in obtaining e reading. To illustrate this int, let it be assumed that too uch water is supplied at a tem- erature less than the wet bulb mperature. A hasty observer ay read the instrument too soon d obtain a reading that is too w. A more experienced observer ould wait until an equilibrium ndition was established at the rrect wet bulb temperature.

Hygroscopic Methods

The use of hygroscopic mate- ials for determining the degree of turation has become widespread. nstruments of this type indicat- ing relative humidity directly may vary in quality from excellent to worthless. The best instruments available have an accuracy about equal to the wet bulb method if they are handled carefully. These are usually the more expensive instruments and should be selected specifically for the ranges of temperature and humidity in which they are to be used. Although these may operate successfully for control purposes, their absolute readings should not be relied upon without frequent calibration. Such calibration is necessary because of possible shift in the *zero* when the instrument is exposed to extreme conditions. These instruments have the advantage of being easy to use, but they are not so well suited to general adaptability as the wet bulb psychrometer, and the need for constant calibration makes them less desirable from the standpoint of maintenance. The less expensive types of hygroscopic instruments are much inferior and cannot be relied upon for any degree of accuracy. Their readings usually must be considered as merely an indication of whether the relative humidity is high or low.

The Dewpoint Method

The dewpoint method is the most direct and has been considered as the standard by which other methods have been checked. In general the accuracy depends upon how elaborate an instrument is available and to what degree it is possible to determine the exact instant when moisture appears on or disappears from a polished surface. Under ideal conditions the error may be less than 1 per cent but it is not adaptable, in its usual form, to many kinds of measurements and in some cases errors of up to 10 per cent may occur. It is best suited for measurements in still air, and for good results the instrument should be observed by means of a telescope located some distance away to avoid effects due to radiation from the observer.

The application of a dewpoint instrument of the usual type to a moving air stream may produce an error of serious magnitude. This is due to the fact that the temperature of the surface on which moisture forms is not the same as the temperature of the fluid used to cool the surface. A dewpoint instrument in a moving air stream will, therefore, tend to read low, and the error will depend on the velocity and humidity of the air stream as well as on the design of the instrument. To eliminate this kind of error, an instrument should be devised which indicates surface temperature rather than the temperature of the fluid cooling the surface.

Serious difficulties may also be encountered when these instruments are used to measure dewpoints below 32 F or to determine relative humidities near saturation or less than 10 per cent. In such cases errors as great as 5 per cent relative humidity may reasonably be expected.

Chemical Methods

Chemical methods operate on the principle of absorption of all the water vapor in a sample of moist air. This is accomplished by the use of some chemical substance or solution having substantially zero vapor pressure, *e. g.* sulphuric acid. The chemical method is considered among the most accurate means for determining humidity. It is not well adapted, however, to rapid sampling or quick reading and it does not lend itself well to portability. With great care, using absolute methods of measurement throughout the analysis of a given sample, accuracy within 0.1 per cent is claimed under conditions of moderate humidity. Under conditions of low humidity, however, or when ordinary methods of measurement are used, errors of from 2 to 3 per cent are common, and with rapidly varying humidities the method is practically worthless.

Electrical Methods

Several electrical methods for determining humidity are in the process of development; since they are still in the experimental stage, little information is available at this time.

The first of these is a thermal conductivity method based on the operation of a gas analysis cell. It was originally developed for use

at the Bell Telephone Laboratories (10). The accuracy claimed for this instrument is plus or minus 0.05 per cent in the range of relative humidity from zero to 10 per cent, at a temperature of 25 deg C (77 F). A commercial modification of the instrument is being developed; but, as yet, it is not ready for general use. While this instrument shows promise of being accurate and capable of operating throughout a wide range, it would have the disadvantage of being primarily a recording type instrument and would not be generally adapted to portability.

Another electrical method was developed at the National Bureau of Standards for use in radiosonde work. It is based on the electrolytic action of a film of partially hydrolized polyvinyl acetate to which is added a small amount of lithium chloride. The amount of lithium chloride depends upon the humidity range to be covered by the unit. The electrical resistance of this film between two coils of palladium wire separated by the film is then a function of the relative humidity. A variation in calibration of not more than 3 per cent relative humidity over a period of time has been reported in radiosonde work (15) (16).

Since the instrument has been developed for a specific application no general claims for its accuracy or adaptability can be made. At the present time it must be considered a laboratory type instrument which must be built specially to suit a given application.

Selection and Application of Instruments

Before selecting an instrument for humidity determination, it is necessary to consider the conditions under which the instrument is to be used as well as the desired accuracy of the result. An examination of Table 1 indicates that, for general application requiring portability, only three instruments—the aspiration psychrometer, the sling psychrometer, and the hygrometer—have errors of less than 3 per cent. Of these three, the sling psychrometer is the most suitable for general purpose work, and, when used with care by an experienced operator, its errors may be reduced to not over 2 per cent. While such errors are undesirable, it will be shown in the next section that errors due to the method of application of the instrument may be much more serious, so that the inherent instrument error often becomes unimportant.

Table 2—Comparison of Wet Bulb Readings Downstream from a Cooling Coil

Coil A in Duct			Coil B in Duct		
Station 1	Station 2	Deviation	Station 1	Station 2	Deviation
64.69	65.37	−0.68	71.64	71.90	−0.26
62.71	62.12	0.59	69.26	69.38	−0.12
73.77	73.78	−0.01	66.80	67.14	−0.34
72.67	71.83	0.84	59.68	59.99	−0.31
61.01	60.56	0.45	58.42	58.65	−0.23
65.23	64.70	0.53	57.32	57.53	−0.21
66.67	66.00	0.67	74.72	74.82	−0.10
69.60	69.18	0.42	73.33	73.63	−0.30
75.53	75.09	0.44	71.82	71.96	−0.14
64.50	63.92	0.58	62.75	62.82	−0.17
71.98	71.90	0.08	61.54	61.53	0.01
74.38	73.95	0.43	59.80	59.92	−0.12
71.17	70.50	0.67			
75.00	74.89	0.11			
74.36	74.21	0.15			
64.88	64.41	0.37			
64.73	64.00	0.73			
61.91	62.54	−0.63			
74.47	74.60	−0.13			
61.53	62.15	0.38			
74.61	73.12	0.49			
74.94	73.72	0.22			
76.60	75.49	0.11			
63.42	62.68	0.74			
63.51	64.25	−0.74			
Average Deviation		0.53	Average Deviation		−0.19

[a]Each wet bulb temperature in this table is the average of 100 readings. Hence, 7400 individual wet bulb readings are represented.

Errors Due to Application

Application errors are due to the conditions under which the instruments are used. In many cases they may reduced, but it is seldom if ever that they can be entirely eliminated. Application errors may be either positive or negative, while instrument errors are usually positive. It is possible, therefore, that under certain conditions, the application error and the inherent instrument error may be compensating. This indicates that the accuracy of a psychrometric determination is an intangible quantity which depends upon both instrument error and application error. To illustrate this point, specific examples of the results of carefully controlled tests are given in Tables 2 and 3.

Accuracy of Psychrometric Determinations

The accuracy of a psychrometric determination is not necessarily the same as the accuracy of a psychrometric instrument. Since it is practically impossible to obtain a completely homogeneous air-vapor mixture throughout a large space, the instrument reading is representative of only a small sample of the mixture at the point where the reading was taken, and it may differ considerably from the true mean value for the space. The degree to which a psychrometric determination approaches the mean condition of the space depends, therefore, upon how nearly homogeneous the mixture as a whole is, and upon how many readings are taken with the instrument.

To illustrate this point, Table 2 gives the results of a test in which two sets of 100 readings each were taken downstream from a cooling coil supplying air to an 18 in. diameter duct. The duct was well insulated to prevent heat loss between the thermometer stations which were about four feet apart, and matched precision thermometers were used at both stations. Four wet bulb thermometers were installed at each station and were spaced equally around the duct. A mixing arrangement was located after the coil to eliminate as much as possible the effects of temperature stratification in the air stream.

It may be seen from Table 2 that with coil A the readings at station 2 were lower (except in five cases) than the readings at station 1. However, when coil B was installed in the duct, even though all other conditions were kept the same, station 2 gave consistently higher readings. This demonstrates that the problem is purely

Table 3—Accuracy of Heat Transfer Results Based on Psychrometric Determinations[a]

Test Data

Temperatures						Pounds of Dry Air Per Hr	Electrical Input Btu/Hr
Station 1			Station 2				
D.B.	W.B.	D.P.	D.B.	W.B.	D.P.		
60.38	59.19	58.40	65.14	61.08	58.70	4750	4625
62.74	61.84	61.31	67.88	63.56	61.18	4790	4400
60.91	60.40	60.10	66.07	62.15	60.00	4610	4425
55.92	55.50	55.20	62.08	58.04	55.50	3200	4510
56.60	56.02	55.77	62.71	58.35	55.68	3090	4550

Comparison of Results

Electrical Input	Heat Transfer Based on W.B. Total Heats		Heat Transfer Based on D.B. and Specific Heat	
Btu per hr	Btu per hr	Percentage Deviation	Btu per hr	Percentage Deviation
4625	5900	27	5480	19
4400	5750	30	5970	35
4425	5440	23	5830	32
4510	5190	15	4880	8
4550	4480	−1.5	4660	2.2

[a]Differences in percentage deviation shown in this table are primarily due to different methods of mixing which were used during the tests. This demonstrates the need for adequate mixing of air streams when psychrometric determinations are being made.

one of mixing and has nothing to do with the accuracy of the instrument itself. The average deviation between station 1 and station 2 for coil A is 0.33 deg wet bulb. This would correspond to an error in relative humidity of about 1.5 per cent while, in this case, the instruments themselves probably had errors of less than 1 per cent. The indicated error of 1.5 per cent is merely the degree to which it is possible to duplicate a determination under the conditions stated, and must not be considered as the absolute error for the determination itself, although it is probably near this value. For coil B the mean deviation is 0.19 deg wet bulb, and this corresponds to an error in relative humidity of about 1 per cent.

To illustrate still further the possible errors in psychrometric determinations due to application of instruments, Table 3 has been prepared. This table indicates something of the degree of absolute accuracy of psychrometric determinations by showing the agreement of heat transfer calculations with actual heat input from an electric heater. Four wet bulb and four dry bulb thermometers were installed at each temperature station before and after the heater; mixers were provided before each temperature station. The system was allowed to come to equilibrium, after which readings were taken of all thermometers every five minutes for two hours, giving a total of 100 readings for each set of thermometers at each station. The heat input was obtained from a watt hour meter standard, ordinarily used only for calibration purposes.

An examination of the dewpoints shown in Table 3 would indicate that the determinations made before and after the heater were accurate, since good agreement was obtained. However, when a heat balance is made, errors as great as 30 per cent may be indicated depending on the method used to calculate the heat transfer, and upon what type of mixing was used. This would lead to the conclusion that neither the dry bulb nor the wet bulb readings are correct, but that they are so related in error that the dewpoints determined from them are in agreement. Another possible explanation is that the water vapor may have been completely mixed or diffused throughout the air stream, while temperature stratification continued.

Conclusions

This review has shown that psychrometric instruments available for general use at the present time are subject to errors of from 1 to 3 per cent relative humidity. Only by using very precise measurements can the humidity be determined within 0.1 per cent, and, unless care is exercised in selection and using instruments, serious errors of as high as 30 per cent may occur. The ability to obtain accurate psychrometric data is more dependent on the application of the instrument than upon the accuracy of the instrument itself.

There is, therefore, a real problem in education to show how the instruments can be used to obtain correct results when applied to air streams and large volumes of air-vapor mixtures such as the general atmosphere of a large room. Since the homogeneity of every atmospheric condition is likely to be different, it seems highly advisable to develop and use a reliable method of check for every application where a high degree of accuracy is desired. In some cases the best that can be done may be to take a large number of readings with two or more different instruments. In other cases, the advantage of a heat balance may be available. Whatever the method of check may be, the responsibility will probably fall to the observer to devise one.

It follows that it is very important that all who use psychrometric instruments for the collection of data to be used for the solution of a specific problem understand the limitation of the instruments and their applications as well as the method of attack for solving the problem.

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F. C. BURNS, 30 YEARS WITH KEWANEE, IS DEAD

Fred C. Burns, branch manager of Kewanee Boiler Corp., Kansas City, Mo., died on July 17, 1946 at the age of 56. He was born July 27, 1890 at Kansas City, Kans., where he attended school. While attending a Trade School he specialized in heating boilers.

He was employed by the Kewanee Boiler Corp. for over thirty years and for the past fifteen years had been the Kansas City Branch Manager.

He had been associated with the ASHVE over a period of eight years and the Officers and Council of the Society extend their deepest sympathy to his widow and son who survive.

Mr. Burns was also a member of the Rotary Club and was a Shriner.

CARL D. BUSHNELL DIES IN PITTSBURGH

Carl D. Bushnell, founder and president of the Bushnell Machinery Co., Pittsburgh, Pa., and a member of the Society for over twenty-five years, died on August 24, in the Allegheny General Hospital, at the age of 65.

Born in Kalamazoo, Mich., he was graduated from the University of Michigan in 1907 with a B.S. in mechanical engineering. His early training was with the Westinghouse Electric and Manufacturing Co., Pennsylvania Steel Pulley Co., and the Pittsburgh Water Heater Co. for which he was mechanical engineer and factory manager. In 1915 he went into business for himself selling mechanical equipment and in 1921 he organized the Bushnell Machinery Co. He spent his entire business career in the Pittsburgh district.

Mr. Bushnell had many friends and associates in the Society and will be missed by his colleagues in the Pittsburgh Chapter, as well as by his associates in the heating and ventilating profession.

He is survived by his widow, Mrs. Helen W. Bushnell; a daughter, Doris, and two sons, John C. and George W. Bushnell, to whom the Officers and Council of the Society extend their sincere sympathy.

HARROLD ENGLISH DIES ON THE COAST

The death of Harrold English, Los Angeles, Calif., president of English and Lauer for the past nineteen years, has been announced. Mr. English was born in 1883 at Richmond, Va. After finishing High School he received private instruction in engineering and in 1906 he was named sales representative of the Buffalo Forge Co. on the Pacific Coast.

He became president of English and Lauer in 1927 and was actively identified with heating, ventilating and air conditioning in Southern California for over thirty-six years. He handled the distribution of the equipment for fourteen leading companies in the air conditioning, cooling, heating and ventilating industry on the Coast. He was instrumental in organizing the Southern California Chapter of the Society and took an active interest in its affairs.

The Council and officers of the AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS extend their heartfelt sympathy to his widow and son, Robson English, who is carrying on for his father in the management of the firm.

OTTO C. ROSS DIES IN INDIANAPOLIS

Word has been received of the death of Otto C. Ross, district manager of the American Air Filter Co., Indianapolis, and owner of the Ross Power Equipment Co., on August 19, 1946, after having been in poor health for a year, although he continued to be active until three weeks before his death.

Mr. Ross was born in 1872 at Angola, Ind. He received his B.S. degree in mechanical engineering from Purdue University in 1895.

Although he was seventy-four when he died, Mr. Ross was looked upon by his friends as a young man because of his keen mentality and his ever active sense of humor. His loss will be felt by a great many of his friends and associates in the heating and ventilating profession.

He is survived by his widow, Mrs. Nell Bowden Ross, to whom the Officers and Council of the Society extend their sincerest sympathy.

Friction Charts for Gases Including Correction for Temperature, Viscosity and Pipe Roughness

By Richard D. Madison* and Walter R. Elliot,** Buffalo

SUMMARY—The solution of problems involving fluid flow and friction will be simplified by means of the charts presented in this paper. Methods of making corrections for temperature, viscosity and pipe roughness are explained and the use of the charts is illustrated by solution of typical problems. These charts are to be used with the ASHVE Air Friction Chart and will extend its range of usefulness.

THE FRICTION loss for fluids of any viscosity and density flowing in pipes having any degree of roughness can be computed from charts based upon two variables, the Reynolds number and relative roughness. Rouse[1] and Moody[2] have prepared such charts. Using these same data, Wright[3] has prepared a simplified chart for the friction of standard air in round, galvanized iron ducts. This simplification limits the flow to standard air but makes application to other gases difficult.

The charts presented with this paper extend the usefulness of the Wright chart and simplify further the solution of problems involving various densities and viscosities. The data used are the same as for the other charts but the friction loss is expressed in number of pipe diameters duct length which would have one velocity head loss. The friction of fluids other than air may be found when they come within the range of the chart.

Streamline and Turbulent Flow

For fluids flowing in conduits the friction loss may be calculated by means of the Darcy equation:

$$h_f = f\left(\frac{L}{D}\right)\left(\frac{V^2}{2g}\right) \quad \text{.....(1)}$$

where

h_f = head loss in feet of the fluid flowing

L = length of pipe in feet

D = diameter of pipe in feet

V = velocity of flow in feet per second

g = acceleration of gravity in feet per second per second

f = friction factor, dimensionless.

Within the region of laminar flow, with Reynolds number less than 2000, the friction factor f is a function of Reynolds number only, and is independent of the roughness of the pipe wall. The values of f are given by:

$$f = \frac{64}{N_{Re}} \quad \text{.....(2)}$$

where

$$N_{Re} = \frac{VD}{v}$$

N_{Re} = Reynolds number, dimensionless

V = Fluid velocity, feet per second

D = Diameter of pipe in feet

v = kinematic viscosity feet^2 per second

In the completely turbulent region the friction factor f depends only on the relative roughness of the pipe wall, and is independent of Reynolds number.

At extremely high velocities with rapidly varying pressures the value of f depends upon the Mach number, which is the ratio of the velocity of the fluid to the velocity of sound in the fluid. Such high velocities are not considered in this paper.

Between Reynolds number values of 2000 and 4000 there exists a critical zone in which flow may be either laminar or turbulent. The condition of flow depends to a large extent upon initial turbulence of the fluid entering the pipe, shock waves, and any other factors which might affect the stability of flow. Above a Reynolds number of 3000 to 4000 flow is definitely turbulent, but not necessarily completely so. In this transition zone, in which lie the majority of cases of air flow encountered in air conditioning applications, the friction factor f depends on both the relative roughness of the pipe wall and on Reynolds number, according to the Colebrook function upon which subsequent analyses have been predicated.

The value of the friction factor f in turbulent flow has been found to vary widely due to differences in manufacturing and fabrication. For example, this variation may be ±10 per cent from the chart values for new steel or wrought iron pipe. In the case of old pipe the value of f can only be estimated in the majority of cases, because the degree of roughness and the reduction in effective diameter are matters for conjecture. As the roughness of very irregular channels such as mine airways cannot be accurately determined estimates of friction losses may vary considerably but such estimates have, however, been applied in practical cases and have been found satisfactory. The velocities usually lie within the completely turbulent region.

The Friction Factor in the Transition Region

In the transition zone in which the fluid is turbulent but not completely turbulent, the Colebrook[4] function expresses the relationship betwen the friction factor,

* Research Engineer, Buffalo Forge Co. Member of ASHVE

** Dept. of Experimental Engineering. Buffalo Forge Co.

[1] Evaluation of Boundary Roughness, by Hunter Rouse. (Proceedings of Second Hydraulic Conference, University of Iowa, Bulletin No. 27, 1943.)

[2] Friction Factors for Pipe Flow, by Lewis F. Moody. (*ASME Transactions*, November, 1944, p. 671.)

[3] A New Friction Chart for Round Ducts, by D. K. Wright, Jr. (ASHVE TRANSACTIONS, Vol. 51, 1945, p. 303.)

[4] Turbulent Flow in Pipes with Particular Reference to the Transition Point Between Smooth and Rough Laws, by C. F. Colebrook. (*Journal of the Institution of Civil Engineers*, London, v. 11, 1938-39, pp. 133-156.)

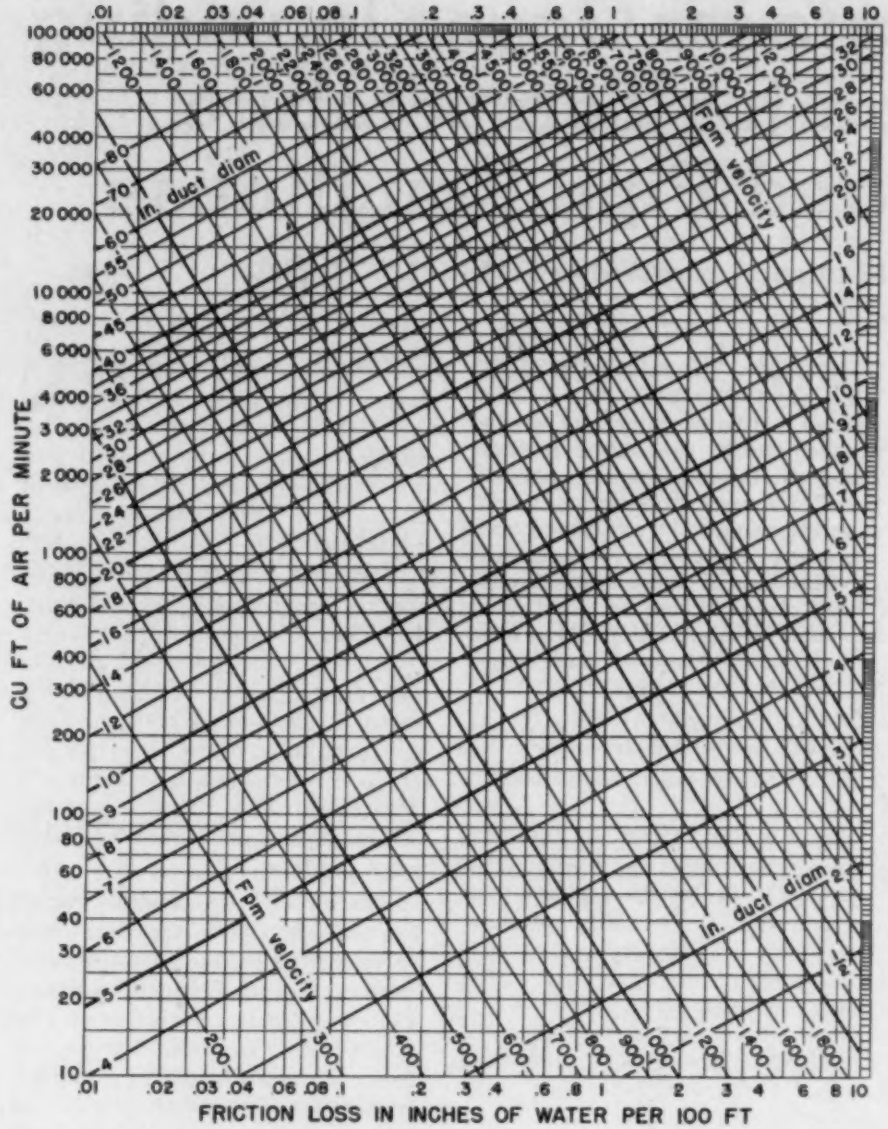

Fig. 1—Friction of air in straight round galvanized duct having 40 joints per 100 ft (based on standard air at 29.921 in. of mercury barometric pressure and 70 F)

pipe roughness and Reynolds number as

$$\frac{1}{\sqrt{f}} = -2\log\left[\frac{\left(\frac{\epsilon}{D}\right)}{3.7} + \frac{2.51}{N_{Re}\sqrt{f}}\right]$$

$$= -2\log\left[\frac{\left(\frac{\epsilon}{D}\right)}{3.7} + \frac{2.51\upsilon}{VD\sqrt{f}}\right] \quad (3)$$

where

f = friction factor, dimensionless
ϵ = pipe roughness, feet
D = pipe diameter, feet
υ = kinematic viscosity, feet² per second
V = fluid velocity, feet per second
$N_{Re} = \frac{VD}{\upsilon}$ = Reynolds number, dimensionless

Friction charts for fluids as for example, Fig. 1, include as variables the pipe diameter, fluid velocity, friction loss and capacity. In addition to these, two other variables should be included as indicated by the Colebrook function, namely, pipe roughness and fluid viscosity, the latter being included in Reynolds number. Therefore it would be desirable to apply suitable correction factors to friction charts drawn for standard conditions but this is not always possible. However, in some cases it can be done in a relatively simple manner as shown in the following text.

Friction Charts

A friction chart for air which is a slight modification of that published in the HEATING, VENTILATING, AIR CONDITIONING GUIDE, 1946 is reproduced in Fig. 1. This chart gives the friction loss for air flowing in galvanized ducts having 40 joints per 100 ft and applies to air weighing 0.075 lb per cu ft. Changes in pressure, temperature and humidity change the viscosity of the air and hence Reynolds

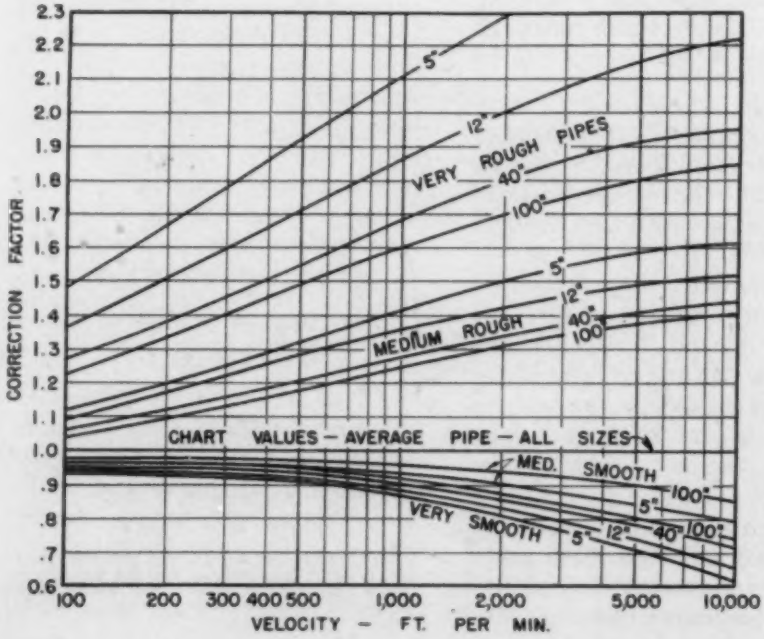

Fig. 2—Correction of friction loss for pipe roughness (multiply friction obtained from Fig. 1 by correction factor corresponding to given velocity roughness and diameter)

Table 1—**Values of Roughness Corresponding to Various Kinds of Pipe Surface**

Pipe	Degree of Roughness	ϵ=Roughness in feet
Drawn Tubing	Very smooth	0.0000015
New Steel or Wrought Iron Pipe	Medium smooth	0.00015
Galvanized Iron	Average	0.0005
Average Concrete	Medium rough	0.003
Average Riveted Steel	Very rough	0.01

number. No correction need be applied for temperatures between 60 and 80 F. Within the usual range of conditions encountered in air conditioning, the error introduced by the variation of the viscosity is small and may be neglected.

For exact work involving larger changes in temperature and pressure than those normally encountered, correction factors should be determined and applied to Fig. 1. This application is difficult since the velocity and diameter each enter Equation 1 twice.

Correction for roughness can be made by use of Fig. 2. Friction loss values obtained from Fig. 1 should be multiplied by the correction factor obtained from Fig. 2 for the given velocity, roughness and diameter.

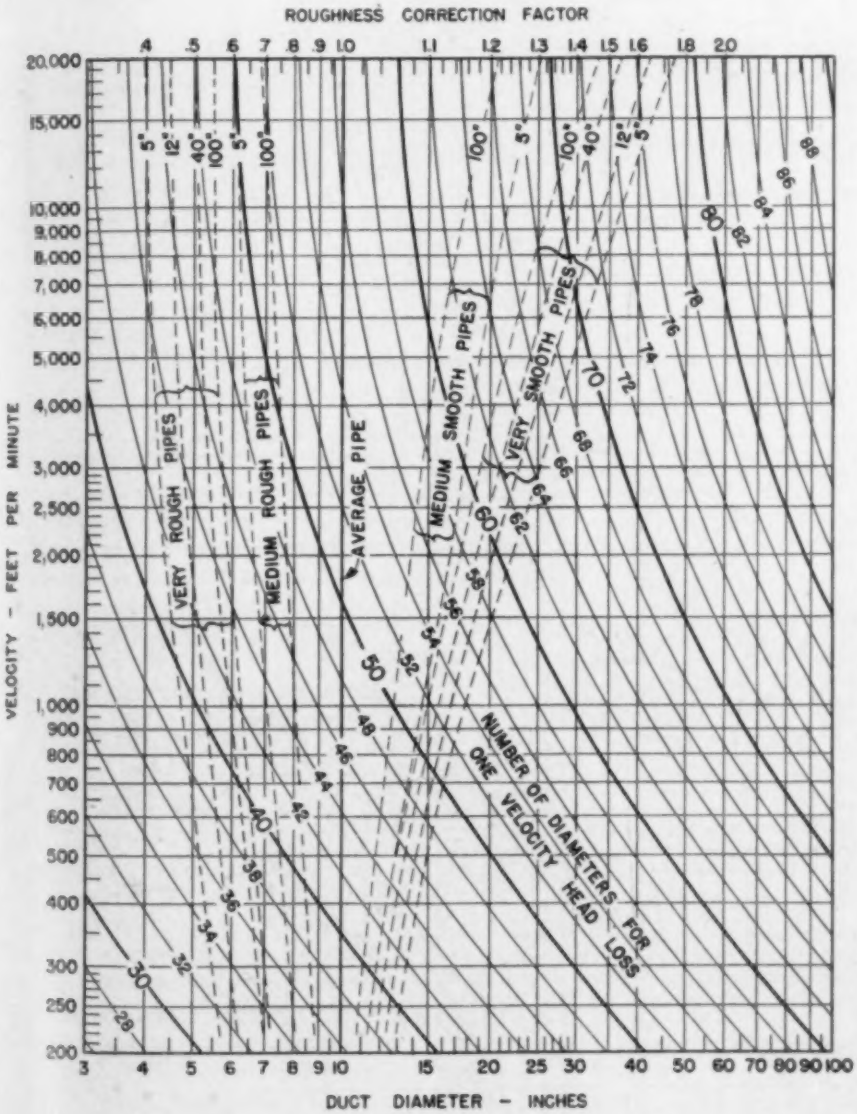

Fig. 3—**Relation between velocity, duct diameter and number of diameters duct length equal to one velocity head friction loss (multiplying factor for roughness also shown on chart)**

These correction factors were computed from the values of roughness ϵ given in Table 1.

It is sometimes convenient to determine directly the number of diameters of duct length having a loss in static pressure of one velocity head. For flow in closed conduits, the Darcy formula is

$$\frac{L}{D} = \frac{h_f}{f\left(\frac{V^2}{2g}\right)} \quad \text{.....(4}$$

Where h_f is equal to $\frac{V^2}{2g}$, the number of diameters for one velocity head loss is a function of the friction factor f only. For the flow of air in galvanized ducts the roughness coefficient of the duct may be considered constant, and for standard air the viscosity and density are also constant. The Darcy equation for this particular case then simply states that the number of diameters of duct length required for a friction loss of one velocity head is a function of f and therefore a function of the diameter and velocity only.

Fig. 3 shows the number of diameters of duct length for one velocity head loss. This chart involves exactly the same information used in the construction of Fig. 1, but is rearranged on rectangular coordinates and is intended to be auxiliary to the ASHVE friction chart Fig. 1.

If the duct has a roughness coefficient other than that for standard duct, a correction factor may also be obtained from Fig. 2 and applied to both Figs. 1 and 3, but is applied as a *multiplier* for Fig. 1 and *divisor* for Fig. 3. In Fig. 3 a similar family of roughness curves has been superimposed on the chart but roughness correction factors obtained from Fig. 3 are to be applied as multiplying constants.

Additional Charts

To facilitate mathematical computations two additional charts have been included. Fig. 4 shows the kinematic viscosity of common fluids over the range of temperatures normally encountered. Fig. 5 gives the

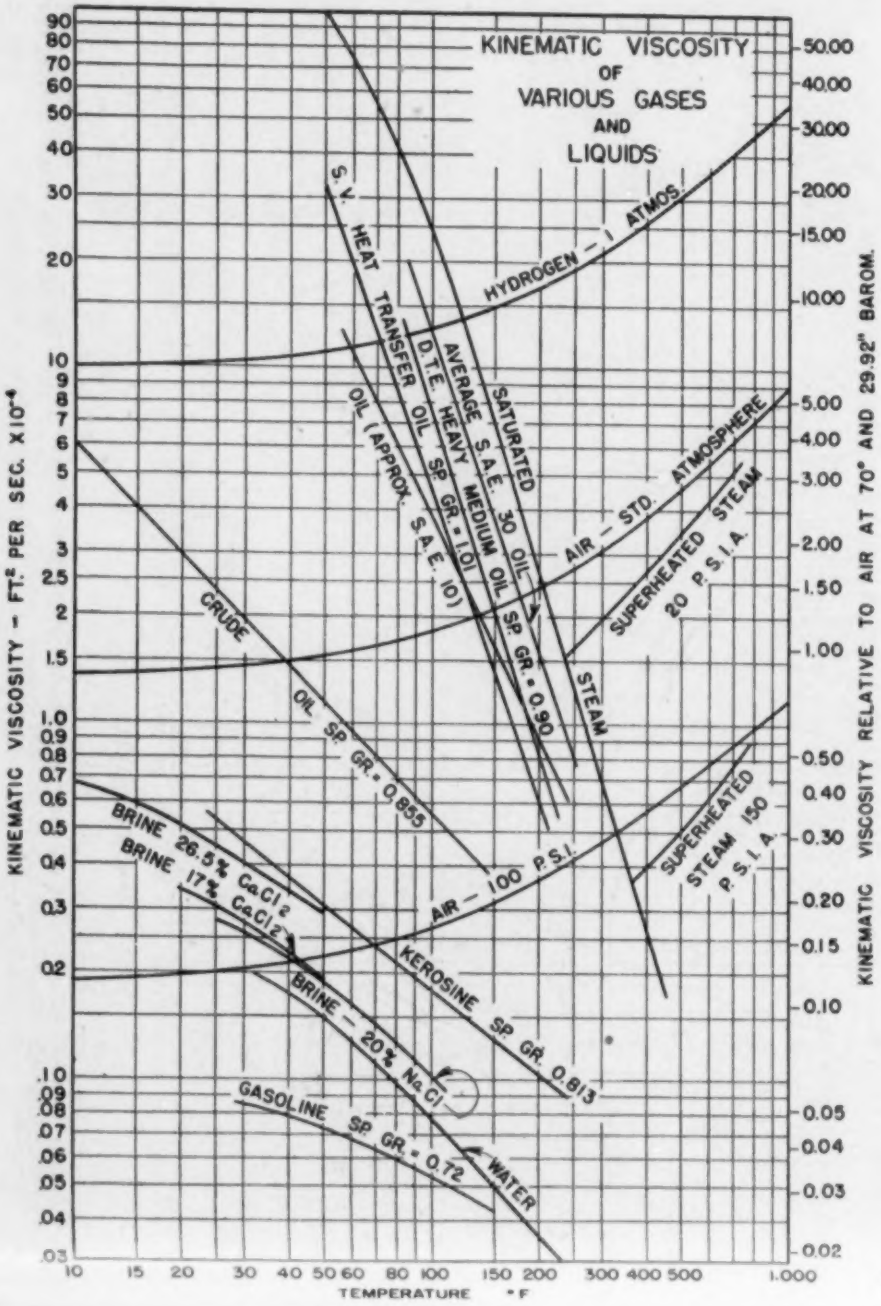

Fig. 4—*(left)* Kinematic viscosity of common fluids within range of temperatures normally encountered

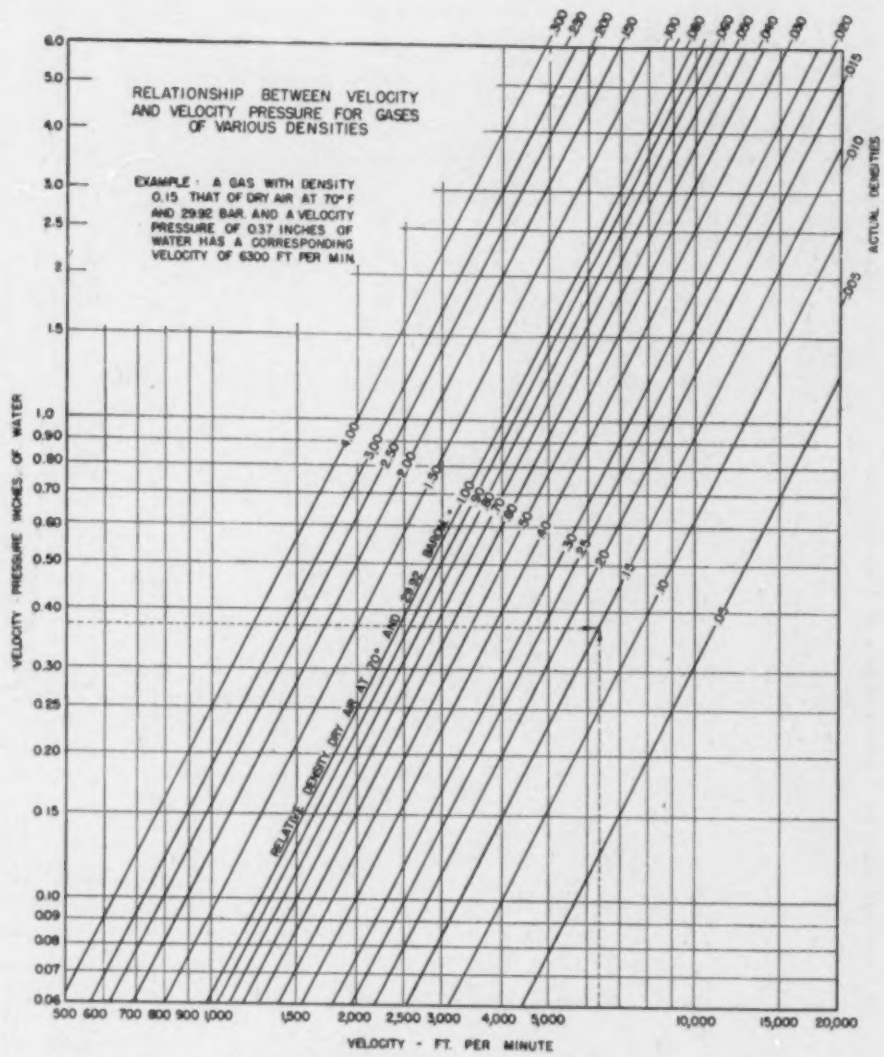
RELATIONSHIP BETWEEN VELOCITY AND VELOCITY PRESSURE FOR GASES OF VARIOUS DENSITIES
EXAMPLE: A GAS WITH DENSITY 0.15 THAT OF DRY AIR AT 70° F AND 29.92 BAR. AND A VELOCITY PRESSURE OF 0.37 INCHES OF WATER HAS A CORRESPONDING VELOCITY OF 6300 FT PER MIN.
VELOCITY PRESSURE INCHES OF WATER
ACTUAL DENSITIES
RELATIVE DENSITY DRY AIR AT 70° AND 29.92 BAROM. = 1.00
VELOCITY - FT. PER MINUTE

Fig. 5—Relationship between velocity and velocity pressure for gases of various densities

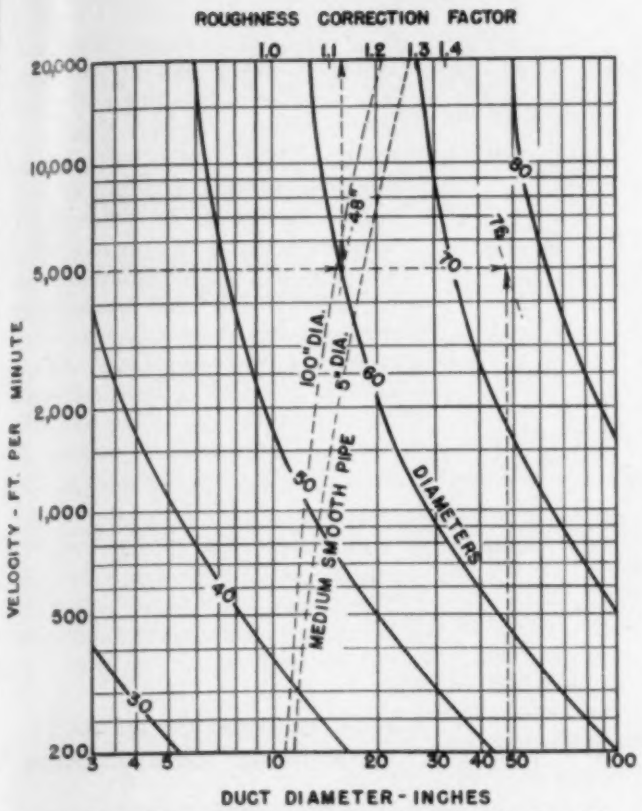

Fig. 6—Chart illustrating use of Fig. 3 in Examples 3 and 4

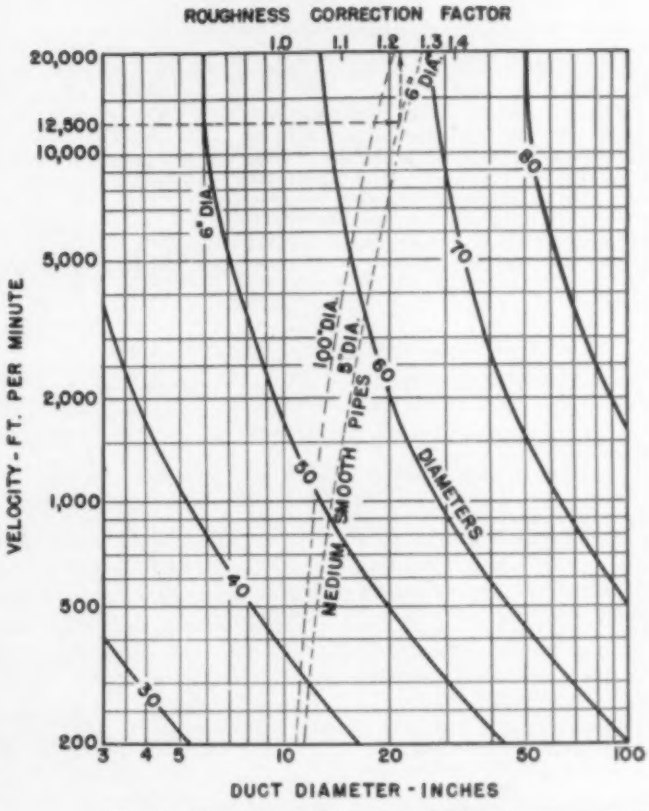

Fig. 7—Chart illustrating use of Fig. 3 in Example 6

relationship between velocity and velocity pressure for gases of various densities.

Correction for Variation in Viscosity

If a correction for viscosity need be applied the number of diameters for the loss of one velocity head can be determined directly from Fig. 3.

For any given pipe (in this case standard galvanized) the friction factor depends on the pipe diameter and on Reynolds number $\frac{VD}{\nu}$

It is seen from the latter, that a change in the fluid viscosity can be accounted for, as far as the Colebrook function is concerned, merely by including an equivalent but reciprocal correction to the fluid *velocity*. For example, if the fluid is other than standard air such that the kinematic viscosity is doubled, the friction factor can be selected as though the viscosity were that of standard air and the velocity halved. It is preferable to *apply this equivalent correction to the velocity* rather than the diameter, as by so doing only one term of the Colebrook function is involved and the procedure is therefore relatively simple.

Examples

Use of these charts can best be illustrated by the following examples.

Example 1. (Use of Fig. 1): A volume of 6000 cfm of standard air is to be delivered through a galvanized duct. What is the minimum allowable duct diameter if the friction loss is not to exceed 0.5 in. water per 100 ft of pipe?

At the intersection of the horizontal line of 6000 cfm capacity and the vertical line 0.5 in. friction loss read 20 in. diameter duct with an air velocity of 2800 fpm.

Example 2. (Correction to Fig. 1 for roughness): If the duct in *Example 1* is very rough instead of galvanized duct with 40 joints per 100 ft and carries the same quantity of air at the same velocity, what will be the friction loss per 100 ft of pipe?

From Fig. 2 for very rough pipe at 2800 fpm and 20 in. diameter find a correction factor of 1.98.

Multiplying the friction loss per 100 ft of standard pipe by this correction factor the head loss is

$$0.5 \times 1.98 = 0.99 \text{ in. water}$$

Example 3. (Use of Fig. 3—Illustration by means of Fig. 6.): Air is delivered at 5000 fpm through a 48 in. galvanized duct. What will be the head loss due to friction in a length of 40 ft?

The velocity pressure[5] read directly from Fig. 5 = 1.55 in. water.

From Fig. 3, interpolating between the horizontal and vertical lines, one velocity head is lost in 76 diameters or $(4 \times 76) = 304$ ft of pipe.

Loss in 40 ft $= \frac{40}{304} \times 1.55 = 0.204$ in. water.

Example 4. (Correction to Fig. 3 for pipe roughness): If the pipe in *Example 3* were medium smooth instead of average galvanized construction how many diameters would be required for the loss of one velocity head?

From Fig. 3 for 48 in. medium smooth pipe at 5000 fpm the correction factor is 1.13.

Number of diameters required $= 76 \times 1.13 = 86$ diameters.

Loss of head in 40 ft $= 0.204 \times 0.866 = 0.175$ in.

Example 5. Correction for change in viscosity): Air is flowing through a 30 in. duct at 6000 fpm. If this air is at 500 F., deduce the length of duct for a friction loss of 1 in. of water.

From Fig. 4 showing kinematic viscosities, the viscosity of air at 70 F is 1.63×10^{-4} and at 500 F is 4.65×10^{-4}. Compared with standard air the ratio is $\frac{4.65 \times 10^{-4}}{1.63 \times 10^{-4}} = 2.85$. (See scale at right hand edge of chart)

The equivalent velocity for use with Fig. 3 is therefore $6000 \times \frac{1}{2.85} = 2100$ fpm.

[5] Velocity Pressure $= \frac{v^2}{2g}$ ft of fluid

where v is in feet per second

$$p_v = \left(\frac{V^2 \times 12}{3600 \times 2 \times 32.2 \times 62.4}\right) \rho \text{ in. water}$$

$$p_v = \left(\frac{V}{1096.5}\right)^2 \rho \text{ in. water}$$

$$p_v = \left(\frac{V}{4005}\right)^2 \text{ in. water for standard air}$$

p_v = velocity pressure in inches of water

where

V = velocity in feet per minute

ρ = density in pounds per cubic foot = 0.075 for standard air

The number of diameters for one velocity head loss is then obtained from Fig. 3 at the intersection of the 2100 velocity line and the 30-in. diameter line, and is 65 diameters.

The velocity pressure varies as the square of the velocity and directly as the density. Since this density varies inversely as the absolute temperature the velocity pressure will also vary inversely as the absolute temperature. The velocity to use in this calculation is the actual velocity and not the equivalent as figured above. In this case the velocity head will be

$$\left(\frac{6000}{4005}\right)^2 \times \frac{460+70}{460+500} = 1.24 \text{ in.}$$

(or may be read at 0.552 relative density from Fig. 5.)

The friction loss is 1.24 in. in 65 diameters of 30 in. duct or in a length of 162.5 ft. Length of pipe for friction loss of 1 in. $= 1/1.24 \times 162.5 = 131$ ft.

Example 6. (Use of charts with fluids other than air—Illustration by means of Fig. 7) Saturated steam at 250 F and 95 per cent quality is flowing through new 6 in. pipe at 10,000 fpm. Calculate the friction loss in a length of 200 ft.

The kinematic viscosity of saturated steam at 250 F from Fig. 4 is
1.3×10^{-4} ft² per second.

Kinematic viscosity of air at 70 F and 29.92 in. barometric pressure.
$= 1.63 \times 10^{-4}$ ft² per second

Ratio compared with standard air $= \frac{1.3 \times 10^{-4}}{1.63 \times 10^{-4}} = 0.80.$

Equivalent velocity to correct for viscosity $= \frac{10,000}{0.80} = 12,500$ fpm.

From Fig. 3 the length of 6 in. pipe for a loss of one velocity head is approximately 50 diameters or 25 ft.

However, in this case medium smooth pipe is called for instead of jointed galvanized pipe, so the correction factor due to roughness is found on the 12,500 velocity line and at a diameter of 6 in. for medium smooth pipe. This is interpolated as a correction factor of 1.24.

The number of diameters of pipe for one velocity head loss is $1.24 \times 50 = 62$ diameters or a length of 31 ft.

The specific volume of steam at 250 F and 95 per cent quality is 13.13 cu ft per pound as compared from the steam tables.

$$\text{The velocity head} = h = \frac{V^2}{2g} \times \frac{\rho}{144}$$

$$= \frac{\left(\frac{10,000}{60}\right)^2}{64.4} \times \frac{1}{13.13 \times 144}$$

$$= 0.228 \text{ psi}$$

where

h = head in psi
V = velocity, feet per second
$\rho = \frac{1}{\text{specific volume}}$ in pounds per cubic foot

The pressure drop in 200 ft of pipe $= \frac{200}{31} \times 0.228 = 1.47$ psi.

In the case of steam the equivalent velocity may be high enough to be off the chart. However, since the lines approach the vertical for high velocities, such points may be determined by extrapolation with little error.

The curve, Fig. 3, can be applied to any fluid, but in actual practice it will be found that the chart can be applied only to fluids in the transition zone where the flow is turbulent but not completely so. Therefore, the chart will be found to be useful for the flow of gases but not for the flow of liquids such as water which are largely used in the completely turbulent region of flow.

Nomenclature Standardization

In connection with the effort to standardize abbreviations, graphical and letter symbols used by the air conditioning and refrigeration industry, the *American Standards Association* Nomenclature Committee B53, sponsored by the *American Society of Refrigerating Engineers,* is endeavoring to find out just what is now being used by the industry. Accordingly, the committee is writing a letter, directing the following questions to two hundred representative firms engaged in refrigeration and air conditioning:

1. What graphical symbols do you use in representing refrigeration equipment within the refrigeration cycle?
2. What letter symbols do you use?
3. What abbreviations do you use?

The scope of the inquiry is limited mainly to nomenclature used in the refrigeration cycle because of the very complete sets of standards already adopted for allied industries and professions such as electrical, mechanical, hydraulics, and piping. Appropriate selections of these standards will be included in the final report of the committee.

Close cooperation is maintained between Committee B53 and similar *American Standards Association* committees, such as Z10, Letter Symbols and Abbreviations Science and Engineering; and Z32, Graphical Symbols and Abbreviations for Use on Drawings—both of which have liaison representatives on B53. While the recipients of the letter were selected as being representative of the industry, the inquiry is by no means limited to them, and the committee hopes that any firm or individual interested in the subject, whether or not they receive a letter, will send in a set of symbols and abbreviations which they use together with any suggestions they may care to offer. Communications should be addressed to D. F. Hayes, secretary, Nomenclature Committee B53, *American Standards Association,* 70 East 45th St., New York 17, N. Y.

Professor M. C. Giannini of New York University is the ASHVE representative on the *American Standards Association* Sectional Committee on Refrigeration Nomenclature.

J. M. CURTICE, COLORADO, ANNOUNCES ORGANIZATION

J. M. "Curt" Curtice has announced his resignation as district manager of the Citizens Utilities Co. and the formation of a new firm to be known as Curtice-Spencer Co., La Junta, Colo. He has been associated with the Citizen's Utilities company for 16 years and has been district manager since 1937.

His early associations were with the Pueblo Gas and Fuel Co., Pueblo, Public Utilities Consolidated Corp., La Junta, and Public Service Co. of Colorado, Fort Collins.

Mr. Curtice joined the Society in 1936 and has been a member of the Rocky Mountain Chapter since its organization.

E. J. LONG ANNOUNCES NEW CONSULTING FIRM

Edward J. Long, Drach Building, 427 E. Washington St., Springfield, Ill., announces the opening of consulting engineering offices, specializing in plumbing and heating design. He was graduated from Springfield Junior College and later attended Carnegie Institute of Technology. During the war he was an Ensign, USNR, and served in the Pacific area as a member of the Submarine Squadron No. 45. He was recently discharged as Lieutenant (j.g.)

NOMINATIONS FOR 1947

Nominations for Officers and Council

The Nominating Committee appointed to select candidates for Officers of the Society for the coming year, 1947, submits the following list of nominees:

For President:
B. M. Woods, Berkeley, Calif.

For First Vice-President:
G. L. Tuve, Cleveland, Ohio

For Second Vice-President:
A. E. Stacey, Jr., Essex Fells, N. J.

For Treasurer:
J. F. Collins, Jr., Pittsburgh, Pa.

For Members of the Council:

Three Year Term

M. W. Bishop, Milwaukee, Wis.
C. F. Boester, Lafayette, Ind.
Leo Hungerford, Los Angeles, Calif.
R. F. Taylor, Houston, Tex.

One Year Term

E. N. McDonnell, Chicago, Ill.

Respectfully submitted,
NOMINATING COMMITTEE,
M. W. Bishop, *Chairman*
C. H. Pesterfield, *Secy.*

In accordance with the provisions of the Society's Constitution, By-Laws and Rules, ballots containing the names of the above candidates will be sent to the membership for voting upon prior to the Annual Meeting in January.

Art. B-IX—*Section 1.* Twenty (20) or more members of the Society, eligible to vote, may present to the Secretary, over their signatures, the name of any member eligible to hold office in the Society as a candidate for any office, provided such name is presented at least (60) days preceding the next Annual Meeting, together with the written consent of the nominee to fill the office for which he has been selected, and the Secretary shall add such names to the ballot if they are not already included in the list of names presented in the formal report of the Nominating Committee. Such names when presented shall be included on the printed ballot, with special notation that they are presented by members independent of the Nominating Committee report. Any member nominated for any office may withdraw his name as a candidate, whether nominated by the regular Nominating Committee or by twenty (20) or more members, providing he does so at least forty-five (45) days prior to the next Annual Meeting.

Art. B-IX—*Section 2.* The Secretary shall prepare ballots with the names of all candidates and forward them to the members, eligible to vote, at least thirty (30) days before the date of the Annual Meeting.

Nominations for Members of Committee on Research

Although committees of the Society are usually appointed, in view of the great importance of the Committee on Research and the responsibility it would be called upon to assume, it has been made more representative of the entire membership of the Society by a process of *election.* The election is governed by the By-Laws for the election of officers, with the single exception that Members of the Committee on Research are nominated by the Council instead of by a Nominating Committee.

In accordance with the provisions of **Art. B-VIII**—*Section 9,* the Council announces the nomination of the following members of the Committee for election to succeed those members whose present terms expire January, 1947.

COMMITTEE ON RESEARCH:

Three Year Term

R. C. Cross, Chicago, Ill.
M. K. Fahnestock, Urbana, Ill.
John James, Cleveland, Ohio
F. J. Kurth, New York, N. Y.
T. H. Urdahl, Washington, D. C.

The regulations governing the nomination and election of members of the Committee on Research are as follows:

Art. B-VIII—*Section 9.* Committee on Research. There shall be a Committee on Research of fifteen (15) members, which shall function in accordance with the Regulations which govern the Committee on Research. The Council shall nominate previous to July first of each year, five (5) members of the Society, to serve for three (3) years, to replace the five (5) members of the Committee on Research whose terms expire at the close of the Annual Meeting of the Society following such nomination. The Council shall vote on the nominees by letter ballot, and the Secretary shall publish the names of the candidates nominated in the October issue of the Journal.

Article II—Research Regulations

(*c*) Any ten (10) members of the Society eligible to vote may present to the Secretary over their signatures, the name of one (1) or more additional nominees for the Committee on Research, provided such name or names are presented at least sixty (60) days prior to the next Annual Meeting, and such additional nominations shall be placed on the ballot opposite the nominations made by the Council.

(*d*) The election shall otherwise conform to the regulations provided for the election of officers of the Society in the Constitution, By-Laws and Rules.

(*e*) Vacancies may be filled by the Council, such persons chosen by the Council to serve until a successor is elected at the next Annual Meeting.

Research Reporter

INDUSTRIAL RESEARCH

L. P. Saunders
Lockport, N. Y.

Research is a form of pioneering in which youth typified by courage, enthusiasm and imagination, has a conspicuous place, L. P. Saunders, Chairman, Committee on Research, told St. Louis Chapter Members recently. This is youth of mind, and many of our foremost inventors were also young in years, the average age of many being represented by approximately 25 years.

According to the National Research Council, industrial research applied to modern industry employs approximately 50,000 persons, 10,000 of whom are engineers. Very few business men appreciate that a long period of development is necessary. The usual length of time required for the development of a new discovery to a state of commercial practicability is from five to eight years. Generally there are no short-cuts.

Industry in the United States is spending about $200,000,000 on industrial research, and the Federal Government about $60,000,000 more in addition to sums by the individual states through state-supported educational institutions. In round figures, about one cent out of each dollar grossed by manufacturing and agriculture in the United States is spent on research. Whether or not, dependent on one's point of view, this is sufficient to keep industry moving up the road of progress, will be answered in the years to come.

THE INTERNATIONAL JOINT COMMITTEE ON PSYCHROMETRIC DATA

J. H. Walker
Detroit, Mich.

This Committee was organized in January 1945 for the purpose of establishing a set of international psychrometric tables as the need for such a standard had been evident for a number of years. A survey disclosed that various organizations and their members were using a variety of tables in which the values differed materially. By joint discussion and interchange of data, it was felt that a set of tables could be prepared which would eliminate differences and provide agreement upon certain fundamental concepts and constants.

In order to facilitate the work on this project, because of the scattered locations of the representatives of the member bodies, a subcommittee was formed to make recommendations as to the fundamental concepts and constants. The subcommittee consists of Dean John A. Goff, *Chairman*, University of Pennsylvania; C. S. Cragoe, National Bureau of Standards; L. P. Harrison, U. S. Weather Bureau; and Dr. F. G. Keyes, Massachusetts Institute of Technology.

A comparison of the various psychrometric tables and charts in use by the members of the various societies represented on the Committee was prepared by Dr. Andrew Gemant, of the Detroit Edison Co., and has been circulated to the representatives of those interested in seeing such comparison.

J. H. Walker, Detroit, is serving as Temporary Chairman, B. M. Dmitrieff, New York, is Temporary Secretary and the organizations represented on the Committee are as follows:

American Institute of Chemical Engineers	J. L. York
American Society of Heating and Ventilating Engineers	Dean John A. Goff
American Society of Mechanical Engineers	B. A. Dmitrieff
American Physical Society	Dr. F. G. Keyes
American Society of Refrigerating Engineers	Prof. B. H. Jennings
Institute of the Aeronautical Sciences	Robert L. Dexter
Institution of Heating and Ventilating Engineers (London, Eng.)	H. H. Bruce
Meteorological Division Air Ministry (London, Eng.)	G. A. Bull
Meteorological Division Canadian Department of Transport	T. J. G. Henry
National Bureau of Standards	C. S. Cragoe
National Physical Laboratory (London, Eng.)	J. P. Mullen
National Research Council of Canada	Dr. C. D. Niven
The Physical Society (London, Eng.)	Prof. David Brunt
U. S. Army Service Forces	Chief—Meteorological Branch
U. S. Navy	Commander R. H. Maynard
U. S. Weather Bureau	L. P. Harrison

RESEARCH PROGRAM ON FILTERS PLANNED

A comprehensive research program on testing methods for air cleaning devices has been undertaken by the Committee on Research and these investigations will be under the direction of the ASHVE Technical Advisory Committee on Air Cleaning, of which R. S. Dill, Bureau of Standards, is chairman.

The Society's earlier studies in this field in cooperation with the University of Minnesota have provided some valuable reports on the effects of various factors on filter performance.

The problem is complex because of the wide variation in both equipment and applications, so that the present program will include an analysis of test methods now employed, followed by an investigation of standard dusts and their preparation. A test code or codes is the ultimate goal of this research and interested organizations have already pledged their support.

COOLING LOAD PROBLEMS

The Technical Advisory Committee on Cooling Load met with members of the Laboratory staff at Cleveland on August 23 under the Chairmanship of W. E. Zieber, and the accompanying photograph shows the members in session.

The Committee prepared recommendations on the following matters:

(a) The importance of clarifying the difference between instantaneous rate of heat gain and cooling load.

(b) Additional practical examples of cooling installations in the HEATING, VENTILATING, AIR CONDITIONING GUIDE.

(c) The correlation of data on methods of calculating periodic heat flow.

(d) The preparation of design tables and design data for periodic heat flow.

(e) Additional studies to evaluate the principle and application of the sol-air thermometer.

(f) The completion of the study of the volumetric specific heat of building materials and the publication of data compiled and determined.

(g) The experimental determination of the absorptivity for sunlight of surfaces covered with exterior paints of various colors.

Technical Advisory Committee on Cooling Load meet with Laboratory Staff

W. E. Zieber
Chairman

(Left to right) C. A. McKeeman, Cyril Tasker, C. M. Humphreys, J. P. Stewart, Prof. C. O. Mackey, Mr. Zieber, R. D. Blum, G. V. Parmelee, J. N. Livermore, R. H. Heilman and H. B. Nottage

Public Square

Come to CLEVELAND for the 53rd Annual Meeting and Exposition

THE Society's Northern Ohio Chapter has extended to all members a cordial invitation "to come to Cleveland for the 53rd Annual Meeting of the ASHVE and the 7th International Heating and Ventilating Exposition."

During 1946 Cleveland celebrates its Sesquicentennial anniversary. It is the sixth largest city in the United States and among its outstanding landmarks are the Public Square, Museum of Art, Municipal Stadium and the Cultural Gardens.

On September 16 at a special meeting of the members of the Committee on Arrangements a program for the entertainment of visitors to the Meeting, which will be held January 27-30, 1947, was outlined. Registration will be opened at the Hotel Statler and committee meetings and technical sessions will be arranged to permit visiting members the greatest opportunity to attend the Exposition. There will be inspection trips and special ceremonies at the Research Laboratory at 7218 Euclid Ave.

It is planned to have a Monday evening party and the annual banquet will be on Wednesday, January 29. There is every indication that there will be a big attendance of members at the meeting and four technical sessions and a joint meet-

Hotel—Name and Location	Single	Double	Twin-Bed
Alcazar Hotel, Surrey at Derbyshire Rd.	$3.00	$5.00	$5.00
Allerton Hotel, Chester at E. 13th St.	2.65-4.50	4.00-6.50	5.00-7.50
	2.00 R.W.	3.00 R.W.	3.00 R.W.
	2.25 R.W.&T.	3.50 R.W.&T.	3.50 R.W.&T.
Auditorium Hotel, St. Clair at E. 6th St.	2.00-3.50	4.00-6.00	4.50-7.00
Belmont, 3844 Euclid Avenue	2.00-4.00	3.00-6.00	4.50-7.00
Bolton Square Hotel, 8907 Carnegie Avenue	2.50-3.00	3.50-4.00	4.50-6.00
Carter Hotel, Prospect at E. 9th Street	4.00-7.00	6.00-8.00	7.00-9.00
Colonial Hotel, 523 Prospect Avenue	2.75-3.00	4.50-5.00	5.00-7.00
	2.00 R.W.	3.50 R.W.	3.50 R.W.
Fenway Hall, Euclid at E. 107th Street	3.00-5.00		5.00-8.00
Fern Hall, 3250 Euclid Avenue	2.00-3.00		3.50-4.00
	1.50 SPB	2.50 SPB	
Garfield Hotel, 3848 Prospect Avenue	1.50-2.00	3.00	3.50
	1.50 R.W.	2.50 R.W.	
Gillsy Hotel, 1811 E. 9th Street	2.00-3.00	3.00-4.00	4.50-5.00
	1.50 R.W.	2.50-3.00 R.W.	3.00 R.W.
Hollenden Hotel, 610 Superior Avenue	3.00-5.00	4.50-6.50	5.00-12.00
Lake Shore Hotel, 12506 Edgewater Drive	3.50		6.00-8.00
Melrose Hotel, 8015 Euclid Avenue	1.25-1.50 R.W.	2.50-3.00 R.W.	3.00 R.W.
New Amsterdam, Euclid at East 22nd Street	2.00-3.00	3.50-4.50	4.50-6.00
	1.50 R.W.	2.50-3.00 R.W.	3.00-3.50 R.W.
Olmsted Hotel, Superior at E. 9th Street	3.00-5.00	5.00-7.00	6.00-8.00
Quad Hall (Men Only), 7500 Euclid Ave.	2.50		4.00
	1.50 R.W.		2.50 R.W.
St. Regis Hotel, 8205 Euclid Avenue	2.50-3.00	3.00-4.00	3.50-6.00
Sovereign Hotel, 1575 East Boulevard	2.50-5.00	4.00-6.00 (suite)	6.00-8.00 (suite)
Statler Hotel, Euclid at E. 12th Street	3.00-6.00	5.00-8.00	5.00-8.00
Stockbridge Hotel, 3228 Euclid Avenue	2.00	3.00	4.00
Tudor Arms Hotel, 10660 Carnegie Avenue	3.50-8.00		5.50-20.00
Wade Park Manor, Park Lane at E. 107th St.	3.50-5.00		5.50-9.00
Westlake Hotel, Blount Rd., Rocky River	3.00-4.00	5.00-6.00	6.00-7.00

Euclid Ave. at 9th St., Cleveland

ing with the *National Warm Air Heating and Air Conditioning Association* are planned.

Among the subjects for discussion at the technical sessions will be radiant heating, application of dehumidification equipment, transmission of odors, air flow into suction openings, and other papers on the medical aspects of atmospheric environment.

All Society members are urged to use the special hotel reservation form which was sent to them for making hotel reservations. When the hotel to which reservation was sent is unable to supply the type of reservation required, the request will be forwarded to the Housing Bureau of the Cleveland Convention and Visitors' Bureau for assignment to another hotel. Direct confirmation in all cases will come direct from the hotel which accepts a reservation.

In addition to inspection trips, which will be arranged by the Northern Ohio Chapter Committee, to various industrial plants, there is much of interest to see in Cleveland for the sightseer among which are the Case School of Applied Science, where the Warner and Swasey Observatory is located, Western Reserve University, one of Ohio's oldest institutions of learning, Severance Hall, nationally known as the home of the Cleveland Symphony Orchestra, Cleveland Museum of Natural History, Dunham Tavern, which is a museum of early Americana.

The 7th International Heating and Ventilating Exposition to be held at Lakeside Hall, Cleveland, during the five days, January 27-31, will be the largest display of equipment in the history of the industry.

Manufacturers who have taken space have disclosed that the number of items produced has increased so greatly that many exhibitors will be able to show only token displays, which will require far less space than if they were to feature their entire list of products.

During the war many new products were produced and many types of equipment redesigned to meet the needs of material shortages.

Visitors to the Exposition will be admitted only by invitation. The Exposition Advisory Committee is headed by Alfred J. Offner, president of the AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS, and the management of the Exposition is under the direction of Charles F. Roth and E. K. Stevens.

COMMITTEE ON ARRANGEMENTS

D. L. Taze, *General Chairman*

Honorary Chairmen

L. T. Avery — C. F. Eveleth — G. L. Tuve

Vice Chairmen

E. B. Cary — F. A. Kitchen
P. D. Gayman — L. S. Ries

J. M. Black, *Secretary*

Banquet—John James, *Chairman;* Walter Baggaley, *Vice-Chairman;* R. W. Dickson, Jr., D. Gladieux, D. E. Mannen, E. W. Philips.

Entertainment—R. L. Clark, *Chairman;* S. R. Guilbert, L. H. Pogalies, E. J. Sable.

Finance—E. F. Morse, *Chairman;* H. W. Heisterkamp, J. F. Platz, J. A. Schurman, A. L. Vanderhoof.

Inspection—L. G. Powers, *Chairman;* W. M. Rowe, *Vice-Chairman;* K. A. Gottschalk, L. H. Jackett, W. P. Miller.

Laboratory—C. M. Humphreys, *Chairman;* R. M. Conner, G. V. Parmelee, J. J. LaSalvia, R. F. Stamberger.

Ladies—R. H. Cutting, *Chairman;* Mrs. R. H. Cutting, Mrs. L. T. Avery, Mrs. P. D. Gayman, Mrs. C. M. Humphreys, Mr. and Mrs. J. P. Jones, Mr. and Mrs. W. R. Rhoton, Mrs. L. S. Ries, Mrs. Cyril Tasker, Mrs. G. L. Tuve.

Publicity—W. R. Moore, *Chairman;* K. T. Davis, W. E. Eynon, R. A. Jack, John Richmond.

Reception—J. E. Wilhelm, *Chairman;* G. P. Nachman, *Vice-Chairman;* J. L. Foley, J. L. Frisse, C. L. Grandstaff, H. L. Repp, W R. Rhoton, L. E. Slawson, H. E. Wetzell, H. K. Jennings (Cincinnati Chapter), R. B. Breneman (Central Ohio Chapter).

Sessions—R. L. Byers, *Chairman;* E. E. Maurer, *Vice-Chairman;* P. M. Berry, J. C. Boehm, Jr., L. C. Burkes, H. F. Curtis, T. D. Dravage, J. K. Kinkaid, A. E. Lavelle, H. A. Tolerton.

Transportation—R. E. Sherman, *Chairman;* L. W. Dunbar, P. B. Fleming, J. A. Hall, C. A. McKeeman, C. R. Matthews.

NOMINEES FOR 1947 OFFICERS

For President—Dr. B. M. Woods, Dir. of University Extension, University of California, Berkeley, Calif., was born in Lampasas, Tex., September 22, 1887. He received his degree of E.E. from the University of Texas in 1908, his M.S. in electrical engineering in 1909, and his degree of Doctor of Philosophy in 1912. He has been associated with the University of California for 35 years.

During the years 1921-1923 he was director of the Summer Session at the University of California at Los Angeles, and from 1923 to 1925 was Assistant Dean of the University. From 1924 to 1930 he was Associate Dean of the University and Representative in Educational Relations. In 1930 he was appointed to the chairmanship of the Mechanical Engineering Department, and in 1942 became Director of the University Extension.

Dr. B. M. Woods
Berkeley, Calif.

In 1936 Dr. Woods took a year's leave from the University to accept appointment in Washington, D. C., with the National Resources Committee as consultant in a Survey of Federal Research in the United States. Returning to the University, he maintained relations with the National Resources Planning Board, serving as chairman of the region covering California, Arizona, Nevada and Utah until it was dissolved by an Act of Congress in 1943. He served as president of the American Society of Planning Officials in 1943, as a member of the National Advisory Committee on Engineering, Science and Management War Training of the U. S. Office of Education, and numerous others.

Dr. Woods, in collaboration with colleagues, has written a book on engineering economy, one on the dynamics of airplanes, and has contributed many miscellaneous technical and non-technical articles to various publications.

He is also a member of the *ASME, SPEE,* a fellow in the American Association for the Advancement of Science, an honorary member of the Air Conditioning Society of San Francisco, a founder member of the Institute of the Aeronautical Sciences, etc., Sigma Xi, Tau Beta Pi, Eta Kappa Nu, and Phi Delta Kappa.

Dr. Woods was instrumental in organizing the Golden Gate Chapter of the ASHVE, and served as its first president in 1937. He has been a member of the Society's Council since 1942, served as chairman of its War Service and the Finance Committees in 1944 and as chairman in 1945 and 1946. As First Vice President he served as chairman of the F. Paul Anderson Award Committee.

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For First Vice-President—G. L. Tuve, Case School of Applied Science, Cleveland, Ohio. Professor Tuve was born on May 26, 1896, at Canton, S. D., where he attended Public School and Augustana Academy. He attended Augustana College, Sioux Falls, S. D., Northwestern University, Evanston, Ill., and received his B.S. and M.E. from the University of Minnesota, Minneapolis, Minn., in 1920 and 1921.

Since receiving his degrees in mechanical engineering he has specialized in heating, ventilating, air conditioning, heat transmission and air flow. His industrial experience has been with the Public Service Co. of Northern Illinois, the Allis-Chalmers Mfg. Co., the American Locomotive Co., and others. After spending some time on the staff of the University of Minnesota he became Assistant Professor of mechanical engineering at the University of Montana, and later became Professor and Head of the Department of Mechanical Engineering at Texas Technological College.

Professor Tuve served as chairman of the Society's Committee on Research for two years, as a member of its Council for five years, as Second Vice-President and a member of the Standards Committee and chairman of the special committee on Technical Papers in 1946. Since joining the ASHVE in 1932 he has served on many of its Research Technical Advisory Committees, as a member of the Meetings, Nominating, Standards, and Guide Publication Committees, and has contributed numerous papers which appear in the Society's JOURNAL and TRANSACTIONS. In his affiliation with the Northern Ohio Chapter, Professor Tuve served on the Board of Governors for a number of years and as its president in 1936.

G. L. Tuve
Cleveland, Ohio

Professor Tuve is co-author with Prof. C. F. Shoop of a text book entitled *Mechanical Engineering Practice,* now in its 7th printing, and used by about 30 engineering colleges. He has been a contributor to Marks' Mechanical Engineers Handbook and to many

technical publications. Professor Tuve is also a member of the *ASME* and the Society for Promotion of Engineering Education, Sigma Xi and Tau Beta Pi.

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For Second Vice President—Alfred E. Stacey, Jr., Essex Fells, N. J., was born on March 10, 1885 at Elbridge, N. Y. He received his preparatory education at the Munroe Collegiate Institute and obtained his M. E. degree from Syracuse University in 1906.

Following his graduation from the University he was employed

Capt. A. E. Stacey, Jr.
Essex Fells, N. J.

as an engineer by the Buffalo Forge Co., Buffalo, N. Y. and in 1908 he joined the staff of the Carrier Air Conditioning Co., New York, as chief engineer. In 1909 he was appointed secretary and shop manager of the Elbridge Chair Co., Elbridge, N. Y., becoming its vice-president in 1911. Later that year he returned to Carrier Air Conditioning Co. as Western Manager with offices in Chicago. He remained in Chicago until May, 1919 when he became chief of research at Carrier Engineering Corp., Newark, N. J. In 1928 he became vice president in charge of research and in 1931 he was appointed vice president in charge of engineering. He served as vice president and technical sales advisor for the corporation in 1934 and 1935.

In December 1935 with A. C. Buensod he organized the firm of Buensod-Stacey Air Conditioning, Inc., New York and served as vice president until he entered the Navy for active service.

In December, 1941 he was on the aircraft carrier Lexington and with others received the commendation of the Commander-in-Chief of the Pacific Fleet. During his Naval service Captain Stacey made contributions to the improvement and design of naval vessels, of such importance that the military effectiveness of certain classes of vessels, including submarines in particular, was materially increased.

He is the author of numerous papers and reports in scientific journals in the chemical, ceramic, and textile engineering fields.

Captain Stacey joined the ASHVE in 1914 when he was located in Chicago and became affiliated with the Illinois Chapter serving as Secretary from 1916 to 1919. Since that time he has taken an active part in the activities of the New York Chapter. He has served on the Society's Council and on many of its special committees as well as a member of the Committee on Research, 1929-31, 1937-39 and as Chairman in 1940-1941. He has also served as chairman and as a member of many code committees and Technical Advisory Committees, including Committees on Corrosion in Air Conditioning Equipment, Transportation Air Conditioning, Air Conditioning in Industry, Heat Transmission, Cooling Load in Summer Air Conditioning, Sound Control and others.

At the 52nd Annual Meeting of the Society in January, 1946, Captain Stacey was awarded the F. Paul Anderson Gold Medal, which is awarded by the Society for distinguished scientific achievement. This award was given to Captain Stacey for his outstanding contributions to the advancement of heating, ventilating and air conditioning.

Captain Stacey is a member of the *American Society of Naval Engineers, American Institute of New York, American Society for Testing Materials, American Society for the Advancement of Science,* and the *Acoustical Society of America,* as well as the Delta Upsilon Fraternity.

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For Treasurer—John F. Collins, Jr., Pittsburgh, Pa. Mr. Collins was born on March 25, 1895, in Pittsburgh, and following his graduation from the public schools in that city and after a short interruption due to World War I, he received his B.S. and C.E. degrees in 1919 from the University of Pittsburgh, School of Engineering.

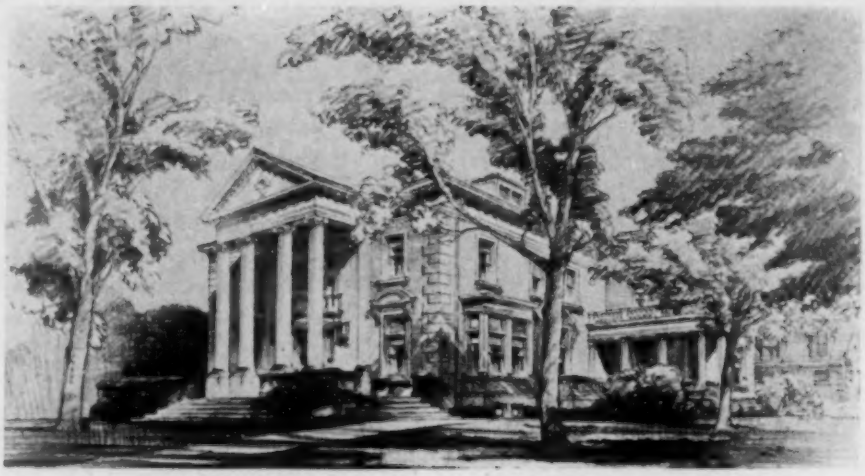
Mr. Collins spent several years with Morris Knowles, Inc., consulting engineers, and for a period of 17 years was employed by the subsidiaries of the Philadelphia Co., supplying gas, light and steam in Pittsburgh, which ended in

J. F. Collins, Jr.
Pittsburgh, Pa.

August 1939, when he became secretary-treasurer of the *National District Heating Association.*

In recent years he successively held the positions of supervisor of Steam Distribution and supervisor of Steam Utilization with the Allegheny County Steam Heating Co., the steam subsidiary of the Philadelphia Co.

Mr. Collins is the author of several papers on district heating; served as president of the Pittsburgh Chapter of the Society in 1938, and from 1942-1945 served as a member of the Society's Council, as chairman of both its Finance Committee and Chapter Relations Committee in 1943, a member of its Membership Committee in 1944 and its chairman in 1945, chairman of the Joint Committee on Weather Statistics, and a member of the Research Technical Advisory Committee on Heat Requirements of Buildings. Mr. Collins served as chairman of the Guide Publication Committee.



Artist's sketch of $100,000 new headquarters of the Engineers' Society of Milwaukee at 3112 W. Highland Blvd.

MILWAUKEE ENGINEERS OPEN NEW HEADQUARTERS

A week of *feverish activity* climaxed by a banquet at the municipal auditorium with Dr. Charles F. Kettering, vice-president in charge of research for General Motors Corp., as featured speaker, is the way Milwaukee engineers celebrated the opening of their new headquarters. Engineers and friends, numbering 1550, attended the dedication dinner on September 21 to hear Dr. Kettering speak on *The Challenge and Opportunities of Tomorrow*. Ernest Szekely, member of the Council, represented the National officers of ASHVE.

The four days, September 18-21 were devoted to the program of dedication and each affiliated Society had on display a panel showing the scope of its activities. The Wisconsin Chapter of ASHVE arranged an attractive exhibit.

In 1944 the Engineers Society of Milwaukee purchased the elegant old home at 3112 West Highland Blvd., built by Frederick Pabst of Pabst Brewery fame. A campaign throughout industry of the area successfully raised a fund of $100,000 to defray the cost of remodeling and equipping the building.

The building was remodeled in keeping with the architectural style of the original structure yet embodying all the latest improvements in construction such as indirect lighting and acoustical ceiling to provide the most modern and complete facilities available. Three small auditoriums, each with a seating capacity of approximately 100 people and so arranged that two of them may be opened to the same program by means of sliding wall panels, are designed for discussion group and technical meeting use.

Founded in 1904 the Engineers' Society of Milwaukee has grown from a mere handful to a membership of 1366 engineers of the Milwaukee area. Embracing all the fields of engineering practice the society's purpose is to improve the knowledge, technical skill, and social usefulness of those engaged in the engineering profession. In keeping with this purpose the Society sponsors monthly meetings with an outstanding nationally known member of the engineering profession as guest speaker, discussion groups which feature symposiums on leading civil or technical topics of the day, and studies of civic items on the behalf of government bodies for the purpose of presenting an unbiased technical opinion.

Through the years various local sections of national engineering organizations have become affiliated with the society so that new horizons for cooperative action have been opened to engineers of Milwaukee. Among affiliated groups are the *American Institute of Electrical Engineers, American Society of Mechanical Engineers, American Society of Civil Engineers, American Society of Refrigerating Engineers,* AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS, the *Institute of Radio Engineers* and the *Illuminating Engineering Society*.

The society publishes a monthly magazine *Milwaukee Engineering*, each issue featuring news about local meetings of both the society and the affiliated organizations, as well as editorials on items of importance.

(left to right) **Henry Oman, secretary, Ernest Szekely, vice president, J. A. Potts, president, E. L. Knebes, past president, L. T. Rosenberg, treasurer**

SUMMARY OF LOCAL CHAPTER MEETINGS*

MANITOBA—Subject: There is an Engineering Reason. (a sound film) presented through the courtesy of Parnall-Waring Co., Philadelphia, and presented by G. C. Davis with the assistance of Robert E. Moore. Pres. F. E. Ball thanked the entertainment committee for the successful outcome of the March 26th get-together with special appreciation extended to G. C. Davis. President Ball appointed the members of the nominating committee, consisting of William Glass, D. F. Michie and G. C. Davis. It was moved and seconded that the invitation of J. C. Davis to have a chapter meeting at his home be accepted. Attendance 16.

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MEMPHIS—July 15. In the absence of Pres. R. H. Hoshall, Vice-Pres. N. C. Ledbetter called the meeting to order. Following the dinner, the minutes of the previous meeting were approved as read and Oliver Holmes, chairman of the auditing committee, reported the treasurer's books in good order. E. E. Scott, chairman of the meetings committee, urged the members to express their opinion as to the most interesting subjects for discussion during the year so that he could plan the year's program. J. D. Flinn, chapter delegate, reported on the Society's Semi-Annual Meeting, in Canada, followed by some interesting comments by General Danielson on the highlights of the Meeting. Attendance 15. Attendance ratio, 0.46.

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NORTH TEXAS—Subject: Illumination in Relation to Air Conditioning and the Human Eye. Speaker: W. E. Folsom, Dallas Power and Light Co. He amplified his talk with effective charts and examples and touched on all phases of lighting insofar as they improved the comfort of working areas. G. A. Linskie, chairman of the program committee, outlined the programs under consideration for the balance of the year and advised that all of them would be extremely worthwhile.

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*Note. The attendance ratio shown represents the membership attendance divided by the chapter membership. This ratio will be useful as a partial indication of interest shown by local chapter members in various types of subjects programmed by the various chapters and may be useful in deciding on subjects for chapter meetings.

CANDIDATES FOR MEMBERSHIP

The Constitution of the Society, as now amended, requires the following mode of procedure in voting on applicants for membership in the Society. All applications for membership are to be sent to the Secretary and the names of applicants and their references shall be printed in the next issue of the JOURNAL of the Society or sent to the members in other approved manner as ordered by the Council. When replies are received from references, the Candidate's application shall be submitted to and acted upon by the Committee on Admission and Advancement as soon as possible.

When the Committee on Admission and Advancement has acted favorably upon a Candidate's application and assigned his grade, the Council shall vote upon the election of the proposed Candidate for membership by letter ballot. During the past month 50 applications for membership have been received and the names of these men and their sponsors are published in the following list.

Members are requested to scrutinize the list with care. The Committee on Admission and Advancement, and in turn, the Council, urge members to assume their share of responsibility of receiving these candidates into membership by advising the Secretary promptly of any whose eligibility for membership is in any way questioned.

All correspondence in regard to such matters is strictly confidential, and is solely for the good of the Society, which it is the duty of every member to promote.

Unless objection is made by some member by October 31, 1946, these candidates will be balloted upon by the Council. Those elected to membership will be notified by the Secretary immediately after election.

ADAMS, ROBERT B., Chief Power Plant Engr., Nordberg Manufacturing Co. PROPOSERS: E. J. Ostermeier, C. M. Burnam, Jr. SECONDERS: C. E. Price, J. S. Locke.

ALLEN, ARNOLD G., Sales Engr., A. G. Allen Co. PROPOSERS: T. R. Davis, Fred Barton. SECONDERS: W. C. Bevington, J. R. Colby.

BADHNI, J., Prop., Badhni Engineering & Trading Co. PROPOSERS: A. Gheselayagh*, K. Karuse*. SECONDERS: G. W. Newton*, A. V. Corry*.

BEAM, LUCIEN H., Supvsr., Utility Operations, Fairchild Aircraft. PROPOSERS: A. F. Chambers, R. W. Martz. SECONDERS: J. T. Moore, J. E. Steinhauer.

DAVIS, ERNEST N., Sales Mgr., London Fan & Motor Co., Ltd. PROPOSERS: J. B. Chadwick, J. R. Kell. SECONDERS: T. H. Gouldbourne, Robert Cupitt.

ELL, WILBUR C., Asst. Engr., B. F. Sturtevant Co. PROPOSERS: A. C. Bartlett, H. R. Sewell. SECONDERS: A. B. Wason, R. E. Reid.

BERTRAM, JOHN F., Dist. Mgr., Minneapolis-Honeywell Regulator Co. PROPOSERS: J. R. Stephenson, D. S. Swain. SECONDERS: Einar Anderson, R. E. Moore.

BOYD, SAMUEL W., Branch Mgr., James B. Clow & Sons. PROPOSERS: C. C. Quin, A. F. Barnes. SECONDERS: R. B. Johnson, D. M. Mills.

BROOME, J. H., Eastern Regional Mgr., Minneapolis-Honeywell Regulator Co. PROPOSERS: C. S. Koehler, Ernst Graber, SECONDERS: J. R. Bergan, L. B. Belford. *(Advancement)*

BUCKALTER, ROBERT I., Tech. Engr., General Electric Co. PROPOSERS: W. E. Johnson, D. W. McLenegan. SECONDERS: E. W. Roessler, R. H. McKibben.

CHRISTENSEN, WALDEMAR H., Sales Engr., Minneapolis-Honeywell Regulator Co. PROPOSERS: R. J. Petersen, Art Theobald. SECONDERS: Leo Hungerford, F. W. Heisinger.

CLARK, HENRY G., JR., Partner, Catlett Engineers. PROPOSERS: Oslin Nation, G. A. Linskie. SECONDERS: J. P. Ashcraft, W. A. Catlett.

DILLON, DEAN A., Dist. Mgr., The Louis Allis Co. PROPOSERS: G. B. Supple, G. Jackson. SECONDERS: S. E. Fenstermaker, Jr., C. H. Hagedon.

DREYER, MARK C., Air Cond. Engr. & Contractor. PROPOSERS: H. R. Frankle, W. T. Swingle. SECONDERS: D. E. Wells, T. R. Johnson.

ELIASON, OSCAR C., Mem. of Tech. Staff, Bell Telephone Laboratories. PROPOSERS: H. C. Murphy, G. W. Penney. SECONDERS: H. H. Glenn*, R. G. M'Cardy*.

ENTENMANN, WERNER O., Research Mech. Engr., Battelle Memorial Institute. PROPOSERS: M. R. Hamlin, H. R. Allonier. SECONDERS: Julian Speer, P. C. Vyff.

FITZGERALD, FRANK R., Sales Engr., Minneapolis-Honeywell Regulator Co. PROPOSERS: A. J. Hess, L. B. Davenport. SECONDERS: J. F. Park, Art Theobald.

GIBBARD, HARRY S., Chief Engr., Norman Products Co., Inc. PROPOSERS: Donald Piper, E. A. Norman, Jr. SECONDERS: A. W. Williams, H. R. Allonier.

GLASER, HARRY D., Engr. & Draftsman, Henry Adams, Inc. PROPOSERS: E. L. Crosby, R. L. Leilich. SECONDERS: E. J. Morris, E. H. Taze.

GOEBEL, HENRY A., Archt. & Draftsman. PROPOSERS: F. C. Barton, C. J. Carlson. SECONDERS: I. W. Cotton, J. A. Nyland.

GRAY, JAMES D., JR., Student, University of Minnesota. PROPOSERS: A. B. Algren, B. F. McLouth. SECONDERS: E. F. Snyder, L. C. Gross.

GROBLER, PIETER S., Engr. Clerk of Works, Provincial Administration, O.F.S. PROPOSERS: R. D. Larter*, J. R. English*. SECONDERS: D. B. C. Meintjies, H. van Coller*.

GUNDERSEN, REIDAR, Engr. PROPOSERS: Fritz Honerkamp, L. R. Phillips, SECONDERS: Elliot Godes, H. K. Kunen.

HILL, JAMES W., Cons. Engr. PROPOSER: A. J. Hess, J. F. Park. SECONDERS: A. G. Small, R. A. Lowe.

HYDEN, HAROLD V., Draftsman, Ammerman, Davis & Stout, Inc. PROPOSERS: S. H. Perham, T. R. Davis. SECONDERS: F. H. Stout*, C. R. Ammerman.

KEARNS, WILLIAM J., Engr., Ingersoll Rand Co. PROPOSERS: C. W. Ellis, J. A. Walsh. SECONDERS: H. C. Will, C. L. Boehler.

LINDHOLM, WILBUR D., Engr. Braniff Engineering Co. PROPOSERS: N. B. Ash, W. M. Carroll. SECONDERS: J. H. Carnahan, W. W. Frankfurt.

LORD, RICHARD H., Pres., P. S. Lord, Mechanical Contractors. PROPOSERS: T. E. Taylor, C. E. Heinkel. SECONDERS: J. P. McDermott, J. D. Kroeker.

MCCLUNG, K. R., Dept. Supvsr., G. A. MacArthur Co. PROPOSERS: A. B. Algren, B. F. McLouth. SECONDERS: B. P. Mooney, H. C. Mills.

MORIN, ROMEO P., Cons. Engr. PROPOSERS: C. W. A. Steinmetz, E. T. Donovan*. SECONDERS: Arthur Ritter, S. E. Lyman. *(Advancement)*

MOSES, WARREN G., Asst. Mgr., Air Cond. Div., Equitable Equipment Co., Inc. PROPOSERS: W. P. Oster, J. S. Adair. SECONDERS: A. R. Salzer, Jr., F. D. Graham.

MULHOLLAND, KENNETH L., Htg. Engr., Sears Roebuck & Co. PROPOSERS: S. L. Boyar, G. A. Baehr. SECONDERS: F. A. Doody, R. C. Boehm.

MYERS, ALBERT F., Mech. Engr., E. Wingfield-Bowles & Partners. PROPOSERS: R. F. Jarrett, Walter Harding. SECONDERS: E. A. Pearce, J. W. Harvey.

NOEL, CLIFFORD E., Mgr. & Partner, Dunham Heating Service. PROPOSERS: O. J. Prentice, C. M. Brigham. SECONDERS: W. C. Zingheim, L. D. Mandell, Jr.

OTT, GEORGE W., Chief Mech. & Engr., Montgomery Ward & Co. PROPOSERS: C. R. Kuglin, M. J. Bamond. SECONDERS: C. M. Burnam Jr., J. S. Locke.

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Nebraska: Organized, 1940. Headquarters, Omaha, Neb. Meets, Second Tuesday. President, H. Y. Kleinkauf, 514 S. 11th St., Omaha 8. Secretary, Verne Simmonds, 2416 Vane St., Omaha 11.

New York: Organized, 1911. Headquarters, New York, N. Y. Meets, Third Monday. President, W. A. Sherbrooke, 114 Liberty St., New York 6. Secretary, Carl H. Flink, Room 3000, 51 Madison Ave., New York 10.

North Carolina: Organized, 1939. Headquarters, Durham, N. C. Meets, Quarterly. President, Arvin Page, 820 Oaklawn Ave., Winston-Salem. Secretary, M. D. Brown, 602 Reynolds Bldg., Winston-Salem.

North Texas: Organized, 1938. Headquarters, Dallas, Tex. Meets, Third Monday. President, E. J. Stern, 701 Burt Bldg., Dallas 1. Secretary, B. S. Foss, Jr., 4703 Ross Ave., Dallas 4.

Northern Ohio: Organized, 1916. Headquarters, Cleveland, Ohio. Meets, Second Monday. President, J. E. Wilhelm, 1906 Euclid Ave., Cleveland 15. Secretary, D. E. Mannen, Jr., 4517 Silsby Rd., University Heights.

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Oklahoma: Organized, 1935. Headquarters, Oklahoma City, Okla. Meets, Second Monday. President, G. T. Donceel, Oklahoma Natural Gas Co., Oklahoma City. Secretary, W. W. Frankfurt, 519 Apco Tower, Oklahoma City.

Ontario: Organized, 1922. Headquarters, Toronto, Ont., Canada. Meets, First Monday. President, V. J. Jenkinson, 117 Peter St., Toronto 2B. Secretary, H. R. Roth, 57 Bloor St., W., Toronto, Ont.

Oregon: Organized, 1939. Headquarters, Portland, Ore. Meets, Thursday after First Tuesday. President, F. F. Urban, 6726 S. W. Burlingame Ave., Portland. Secretary, E. R. Lokey, 1238 N. W. Glisan St., Portland 9.

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Pacific Northwest: Organized, 1928. Headquarters, Seattle, Wash. Meets, Second Tuesday. President, R. E. Le Riche, 6345 39th S. W., Seattle 6. Secretary, C. W. Finn, 320 - 8th Ave. N., Seattle 9.

Philadelphia: Organized, 1916. Hadquarters, Philadelphia, Pa. Meets, Second Thursday. President, R. D. Touton, Ninth & Columbia Ave., Philadelphia. Secretary, F. H. Buzzard, 213 S. Broad St., Philadelphia 7.

Pittsburgh: Organized, 1919. Headquarters, Pittsburgh, Pa. Meets, Second Monday. President, A. F. Nass, 527 First Ave., Pittsburgh 19. Secretary, E. H. Riesmeyer, Jr., 231-33 Water St., Pittsburgh 22.

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Rocky Mountain: Organized, 1944. Headquarters, Denver, Colo. Meets, First Wednesday. President, F. L. Adams, P. O. Box 840. Denver 1. Secretary, J. J. Johnson, 1010 17th St., Denver 2.

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St. Louis: Organized, 1928. Headquarters, St. Louis, Mo. Meets, First Tuesday. President, B. C. Simons, 4030 Chouteau, St. Louis 10. Secretary, W. A. Russell, 7918 Kingsbury Blvd., Clayton 5, Mo.

South Texas: Organized, 1938. Headquarters, Houston, Tex. Meets, Third Friday. President, B. P. Fisher, P. O. Box 92, Houston 1. Secretary, C. C. Quin, 809 Stuart Ave., Houston 6.

Southern California: Organized, 1930. Headquarters, Los Angeles, Calif. Meets, Second Wednesday. President, Art Theobald, 1161½ S. Kings Rd. Secretary, R. S. Farr, 2615 Southwest Dr., Los Angeles 43.

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Utah: Organized, 1944. Headquarters, Salt Lake City, Utah. Meets, First Wednesday. President, J. T. Young, Jr., Box 709, Ogden. Secretary, E. J. Watts, 2485 Douglas St., Salt Lake City 5.

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Virginia: Organized, 1946. Headquarters, Norfolk, Va. President, R. C. Thomas, 819 Westover Ave., Norfolk 7. Secretary, J. F. Reynolds, Gatling and Marble Ave., Norfolk 2.

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Washington, D. C.: Organized, 1935. Headquarters, Washington, D. C. Meets, Second Wednesday. President, L. B. Nye, Jr., 1100 H St., N. W., Washington. Secretary, J. N. Stewart, 6124 32nd Pl., N. W., Washington 15.

Western Michigan: Organized, 1931. Headquarters, Grand Rapids, Mich. Meets, Second Monday. President, J. W. Miller, Route 5, Box 498, Lansing. Secretary, K. E. Robinson, 211 Smith Ave., Lansing 10.

Western New York: Organized, 1919. Headquarters, Buffalo, N. Y. Meets, Second Monday. President, Herman Seelbach, Jr., 45 Allen St., Buffalo 2. Secretary, F. J. Weber, 443 Delaware Ave., Buffalo 4.

Wisconsin: Organized, 1922. Headquarters, Milwaukee, Wis. Meets, Third Monday. President, E. W. Gifford, 611 N. Broadway, Milwaukee 2. Secretary, B. M. Kluge, 1817 S 66th St., Milwaukee 14.

INSTRUMENT MAKERS MEET AT PITTSBURGH

At the first annual conference of the Instrument Society of America, held at the William Penn Hotel, Pittsburgh, Pa., September 16-18, new officers were elected as follows: *President,* C. O. Fairchild, New York; *vice-presidents,* C. F. Kayan, New York; H. H. Barnum, Detroit; R. D. Munch, St. Louis, and J. B. McMahon, Chicago; and *treasurer,* H. E. Ferguson, Chicago; and *secretary,* Richard Rimbach, Pittsburgh.

Professor Kayan, one of the newly elected vice-presidents, is assistant professor of mechanical engineering at Columbia University, a member of the ASHVE Guide Publication Committee, and a member of the Board of Governors of the New York Chapter of ASHVE.

In addition to the technical meetings there was a large display of equipment, ranging from huge gauges to tiny electronic micrometers produced by the leading instrument makers of the nation.

The members present also saw the first public showing of the official colored motion pictures of the Bikini atom bomb tests and heard Rear Admiral Luis de Florez, assistant chief of research and inventions for the U. S. Navy, who warned that men have about reached the limit of their ability to think quick. He stated "men are the limiting factor in instrumentation, and you've got to design for them. . . . You'll have to make the instrument read in some terms that will be more or less instinctive. If you don't we won't be able to capitalize on the developments of future science."

An Invitation to Members

The Council wishes to encourage authors to contribute good technical papers for presentation to our Society, particularly papers dealing with new or novel developments. Good papers on air conditioning of all kinds and new papers on air distribution, industrial hygiene and industrial ventilation are of interest. A special committee has been appointed to secure papers. The membership of the Committee on Technical Papers is composed of G. L. Tuve, chairman; L. T. Avery, Walter Heibel, C. H. Flink, and Cyril Tasker.

Any one of the committee members will be glad to consult by mail or otherwise with authors to predetermine whether the particular subject is desired.

Papers must be presented first to the Publication Committee for approval for publication and then are passed on to the Meetings Committee for selection to use at the Annual or Semi-Annual Meetings. We need papers planned now to take care of the Annual Meeting in January, 1947. If you have any papers you would like to suggest, please communicate with any of the committee members.

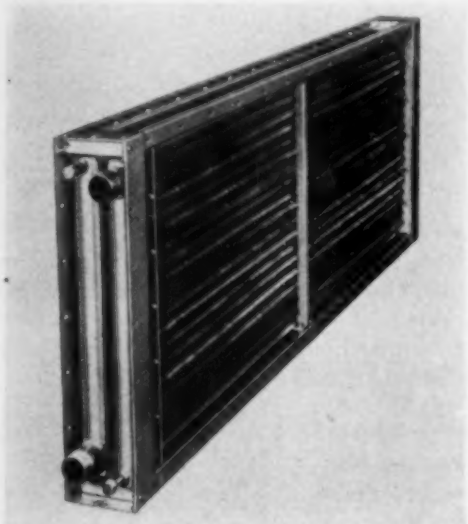
EQUIPMENT DEVELOPMENTS

For your convenience in obtaining more information about any of this equipment, see coupon on this page. Add the new products and companies listed here to your Directory Section which you received in your January 1946 Heating, Piping & Air Conditioning and thus keep your records of sources of supply up to date throughout the year. Single asterisk indicates equipment not listed in Directory Section; double asterisk equipment and manufacturer not listed.

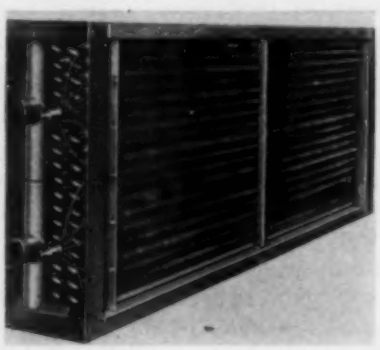
Heating and Cooling Coils

No. 3250—The American Blower Corp., Detroit 32, Mich., is now producing an extensive post war line of heating and cooling coils.

All heating and cooling coils are made of ⅝ in. O.D. admiralty metal seamless tubing of 0.031 in. wall thickness. This tubing is helically wound with 13/32 in. copper ribbon in three standard spacings. The regular spacing has the greatest capacity and is the most economical for usual applications while the intermediate spacing has a lower capacity and a lower air pressure drop. In cooling coils the wide fin spacing is used in low temperature applications to minimize the effect of frost. In heating coils the wide fin spacing is used in tempering coils and with high pressure steam where low temperature rise is required.



The line of heating coils includes steam coils for blast heating, steam booster coils for zone reheating, return bend coils for both steam and hot water (upper illustration), and double tube coils for modulated steam control.

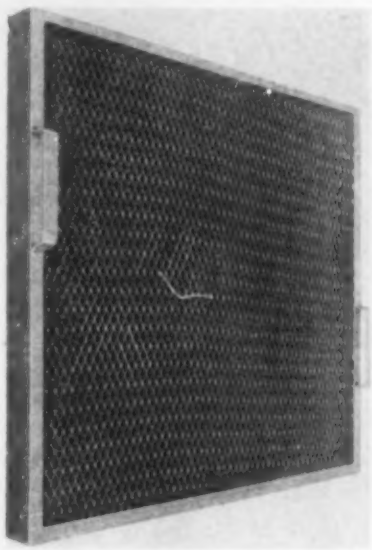


Both water and direct expansion coils are of the serpentine type with continuous coolant circuits from the inlet header or distributor to the outlet header. Water coil headers are of heavy, formed steel with reentrant tubes designed to meter the liquids to the circuits. Direct expansion refrigeration distributors are of brass of the calibrated orifice type. Suction headers are of steel dipped in a tin-lead mixture after fabrication. A direct expansion coil is shown in the lower illustration.

High Velocity Air Filter

No. 3251—A new all-metal, permanent and cleanable "Agitair FM" air filter has been developed by Air Devices, Inc., 17 E. 42nd St., New York 17, N. Y.

The 20 x 20 in. filter is designed to handle 1200 cfm and the filtering medium consists of layers of expanded metal so disposed as to induce turbulent cyclonic action of the air within the filter. The unit is said to operate at high velocities with sustained low resistance to air flow, maximum dust holding capacity, and extremely high dust removal efficiency. The frame is constructed of cold rolled steel and is arc welded.



Ammeters and Voltmeters

No. 3252—A new line of d-c moving vane type ammeters and voltmeters has been announced by the United States Gauge Div., American Machine and Metals, Inc., Sellersville, Pa.

Noteworthy features are said to include the reduction of oscillation to a minimum by a new high torque, lightweight movement and the use of long, easy to read scales. Dials have a scale length of 80 deg of an arc on the center zero type scale and 60 deg of an arc on the zero off-center scales.

Heating, Piping & Air Conditioning, [10-46]
6 N. Michigan Ave., Chicago 2, Ill.

Please ask the manufacturers to send me more information about the equipment mentioned under the following reference numbers in Equipment Developments and Recent Trade Literature.

(Circle each number in which you are interested)

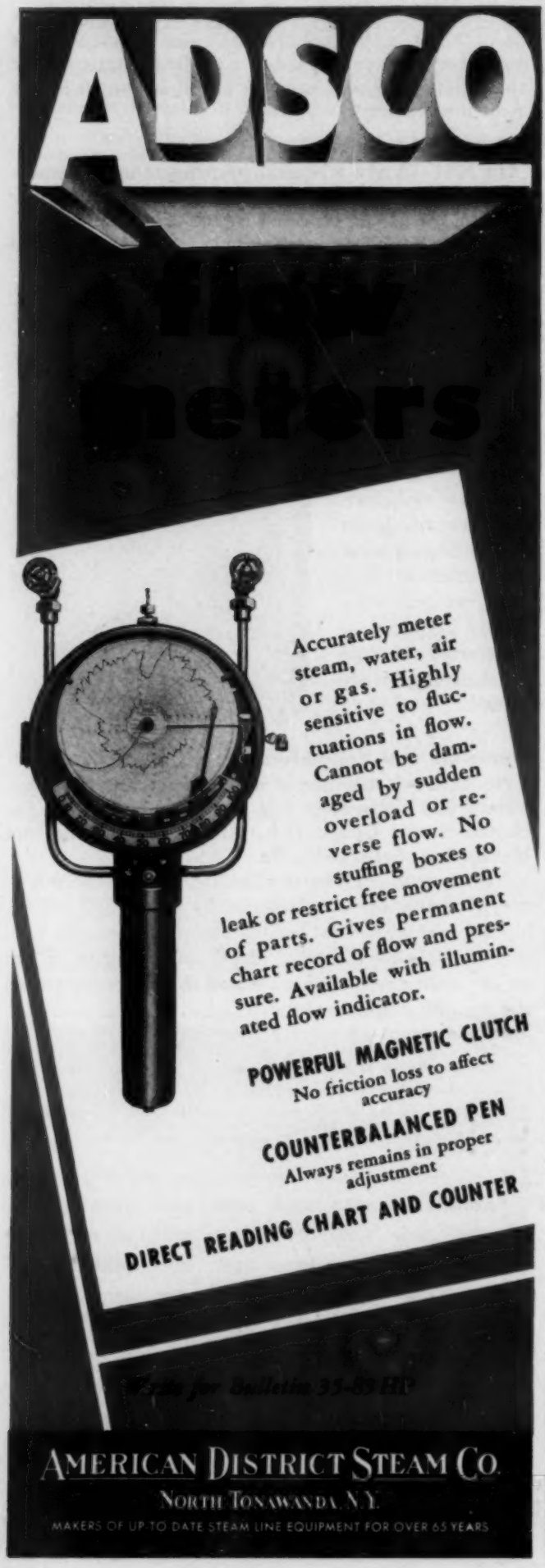
3250	3251	3252	3253	3254	3255	3256	3257
3258	3259	3260	3261	3262	3263	3264	
6293	6294	6295	6296	6297	6298	6299	6300
6301	6302	6303	6304	6305	6306	6307	6308
6309	6310	6311	6312	6313	6314	6315	

Name..... Title.....

Company .....

Address .....

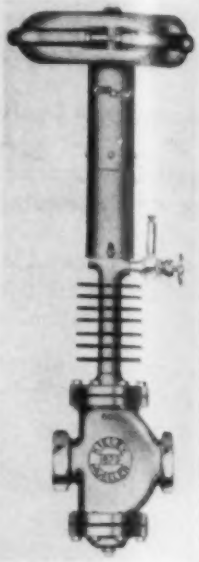
City..... Zone..... State.....


ADSCO
meters
Accurately meter steam, water, air or gas. Highly sensitive to fluctuations in flow. Cannot be damaged by sudden overload or reverse flow. No stuffing boxes to leak or restrict free movement of parts. Gives permanent chart record of flow and pressure. Available with illuminated flow indicator.
POWERFUL MAGNETIC CLUTCH
No friction loss to affect accuracy
COUNTERBALANCED PEN
Always remains in proper adjustment
DIRECT READING CHART AND COUNTER
Write for Bulletin 35-83 HP
AMERICAN DISTRICT STEAM CO.
NORTH TONAWANDA, N.Y.
MAKERS OF UP TO DATE STEAM LINE EQUIPMENT FOR OVER 65 YEARS

Diaphragm Valves

No. 3253—Announcement has been made by Kieley & Mueller, Inc., 2015 43rd St., North Bergen, N. J., of a new line of "Kontrol Motor" diaphragm valves for pressure regulators, pump governors, and diaphragm motor control valves.

These valves feature light weight, all steel diaphragm motor construction. The diaphragm casings are boltless, assembled with quick-acting clamp rings and diaphragms are molded reinforced neoprene. The manufacturer states that unusually large effective diaphragm areas combined with heavy, fully enclosed, heat treated springs provide maximum power.



Valve position indicators are furnished as standard, and valve bodies are of high capacity, with unrestricted flow areas. Units are available in bronze, semi-steel, cast steel, and special alloys. A wide variety of trim material may be supplied and quick opening, percentage V port, and parabolic discs may be used.

New Unit Heater Line

No. 3254—A new postwar line of propeller type unit heaters has been announced by Modine Mfg. Co., Racine, Wis.

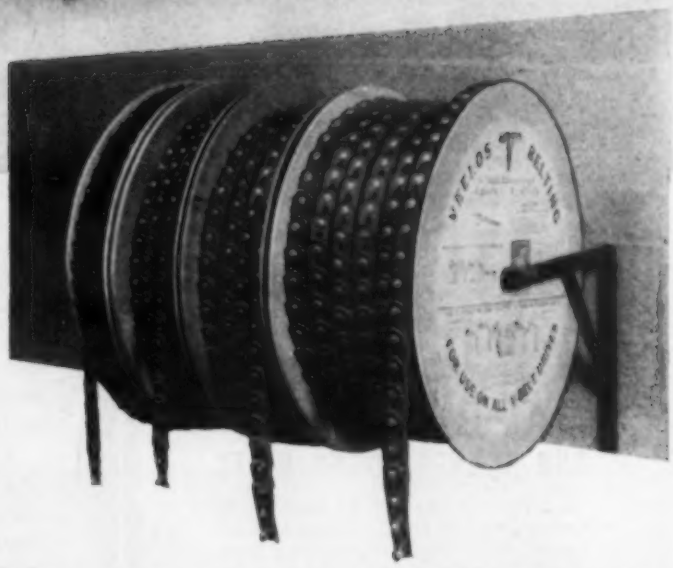
Now in production, these 1947 models feature three types of units with a total of 47 basic capacities. To the conventional horizontal and vertical delivery types the company has added a new draw-through unit designed to provide horizontal discharge of heated air over an extra long range. Known as the "Power-Throw," this unit (shown here) has specialized applications and may be used alone or in combination with the other types.

All three types are available in standard models as well as in models designed to provide low outlet air temperatures when used on steam pressures of 30 psi or more. Models for hot water applications and for drying and processing jobs are also included in the line. Construction features include an integral all-brazed copper condenser, acoustically insulated casings, and copper tubes and headers which are brazed to form rugged units with copper fins mechanically and metallically bonded to tubes.

Engineer's Sketch Pad

No. 3255—Jiffy Sales Co., 1802 E. 37th St., Cleveland 14, Ohio, has introduced a new engineer's sketch pad designed to facilitate and speed up the preparation of sketches, both in the office and in the field.

The pad contains 75 sheets of 9 x 12 in. tracing tissue



316 sizes OF ENDLESS V-BELTS CAN BE Replaced with only 4 sizes of Veelos

FROM only four widths of Veelos—the link V-belt—you can make up 316 standard sizes of industrial and fractional endless V-belts. There's no need to stock spare sets of endless belts for each drive.

Large, costly inventories are eliminated... no deterioration of spare belts... no obsolescence.

Veelos on reels saves stockroom space... reduces inventory records... *is easy to locate and easy to install.*

Made in all standard sizes... fits all standard V-belt grooves ...available in standard 100-foot reels.

VEELOS
THE LINK
V-BELT
Adjustable to any Length
Adaptable to any Drive

MANHEIM MANUFACTURING & BELTING CO., MANHEIM, PA.

Tested • Proved • Adopted by American Industry

Boilers made in 6 sizes
up to 3040 sq. ft.
E. D. R. steam.

ALDRICH
HEAT-PAK OIL BURNERS
AND BURNER-BOILER UNITS

. . . because the name, ALDRICH, means quality! It is a reputation attained after years of manufacturing experience, engineering leadership, designing skill. For conclusive proof of performance and efficiency on the job, Aldrich HEAT-PAK products were standard equipment in U. S. Insular Bases. Aldrich, the leading oil burner manufacturer, *guarantees* satisfactory performance!

Because Aldrich will not sacrifice standards of quality, production will be slow until the shortage of good materials is overcome.

Model AX
.75 to 5.00 G.P.H.
Model BX
4.00 to 9.00 G.P.H.
Jumbo
5.00 to 19.00 G.P.H.

KNOWN and USED the WORLD AROUND!

ALDRICH COMPANY
WYOMING ILLINOIS

enclosed within a cover jacket which consists of four cardboard flaps. To provide accuracy in laying out lines, various scales are printed on three of the flaps. In using the pad a cover flap is folded over and one of the tissue sheets is placed over the desired scale.

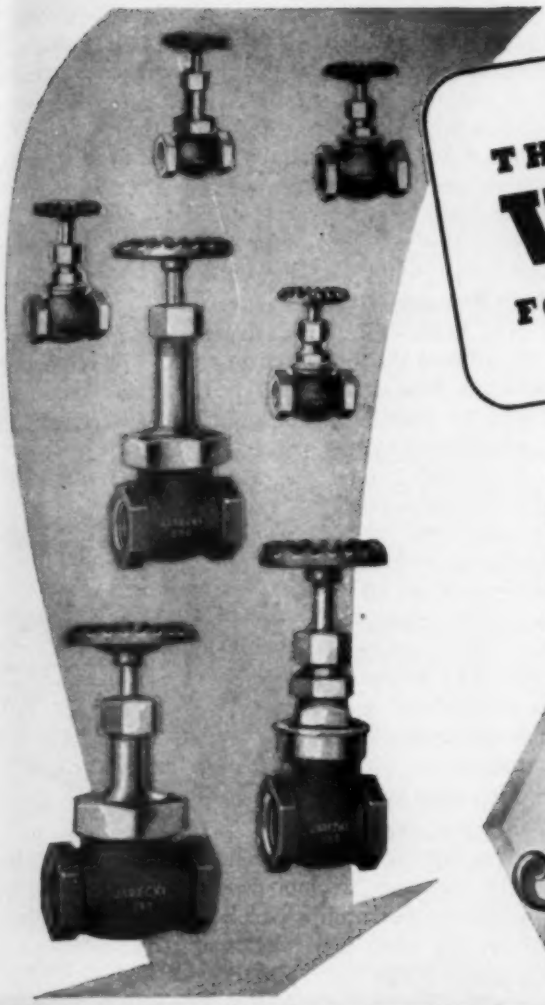
According the the manufacturer, the pad has been endorsed by draftsmen, designers, engineers, surveyors, builders, field men, sales engineers, students, estimators, patent attorneys, and architects. It is said to be a real time saver and drawings made on this pad may be readily blue printed with no guide lines showing. Sheets are perforated for easy removal and technical data such as drafting standards; electrical, welding, and architectural symbols; decimal equivalents; and circumferences and areas of circles are included on the back of the flaps.

Induction Motors

No. 3256—After a period of extensive development and research, Westinghouse Electric Corp., East Pittsburgh, Pa., is offering a new "Life-Line" induction motor in integral horsepower sizes.

These new industrial a-c motors feature the use of heavy steel construction and special ball bearings and are said to be more than 35 per cent smaller in size than previous models. It is also stated that starting torques have been increased as much as 134 per cent per lb of motor and maximum torques have been increased as much as 116 per cent per lb of motor.

The use of steel construction for the frame and end bells is said to provide great strength, resistance to shock, and to make possible the smaller size. Thicknesses of steel as used are approximately the same as would be used in similar cast iron sections. According to the manufacturer, it is a fallacy that steel corrodes faster than cast iron as tests have demonstrated that the two materials corrode at equal rates.



THE CORRECT VALVE FOR THE JOB

FOR YOUR CONVENIENCE . . . Yes . . . and for *your profit* in buying the Modern Way, Jarecki Valves are packaged. Thus, type and size selections are quick and accurate . . . Your stock is "on display", neatly and efficiently classified . . . Your service on Domestic and Industrial Valves is improved.

Since 1852

JARECKI

Valves and Fittings

You Name it . . . They Drive it

Self-Tapping Screws • Wood Screws • Machine Screws • Nuts and Bolts

B & D POSITIVE CLUTCH SCRUGUN speeds up production on such jobs as fabricating air conditioning ducts.

ADJUSTABLE CLUTCH SCRUGUN . . . one of many Black & Decker models . . . automatically drives screws and nuts to uniform tension.

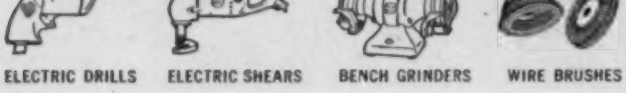
Black & Decker Electric Screw Drivers and Nut Runners speed up every type of sheet metal assembly work . . . from the most delicate screw driving operations to driving and tightening nuts and bolts up to 1″ diameter or lag screws up to ¾″ x 6″. Light, compact, easy to handle . . . these powerful tools insure top-speed performance with greater accuracy and uniformity and minimum operator fatigue.

For full information about all models . . . and other Electric Tools for heating, piping and air conditioning work . . . see your nearby Black & Decker Distributor. For your free copy of our 60-page, illustrated "Power Assembly Tool Data Book," write to: The Black & Decker Mfg. Co., 628 Penna. Ave., Towson 4, Md.

LEADING DISTRIBUTORS EVERYWHERE SELL

Black & Decker

PORTABLE ELECTRIC TOOLS



ELECTRIC DRILLS ELECTRIC SHEARS BENCH GRINDERS WIRE BRUSHES

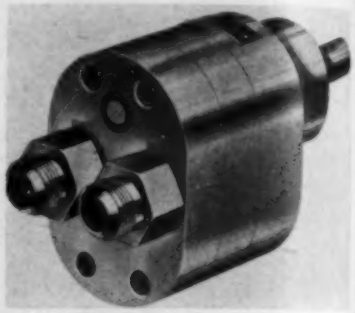
Other features include an improved ventilating system for cooling the motor, the use of precision manufacturing procedures, which with dynetric balancing, are said to minimize vibration, the use of prelubricated ball bearings which do not require attention for five years, and the use of many common parts which are interchangeable on other types and sizes of motors.

The line will include splash proof, open-protected, and totally-enclosed, fan-cooled motors.

High Pressure Pump

No. 3257—The direct drive, spur gear pump, Series 700, offered by the McIntyre Co., 714 Riverdale Ave., Newton, Mass., has been designed for capacities from 0.4 to 9.6 gpm at speeds up to 1750 rpm and against pressures up to 1000 psi.

This small 6-lb. unit is said to operate with a volumetric efficiency in excess of 90 per cent and a mechanical efficiency of better than 80 per cent. It is offered for many applications including material handling equipment, machine tools, oil well sampling, power transmission, proportioning equipment, and low capacity pressure circulation and delivery functions.

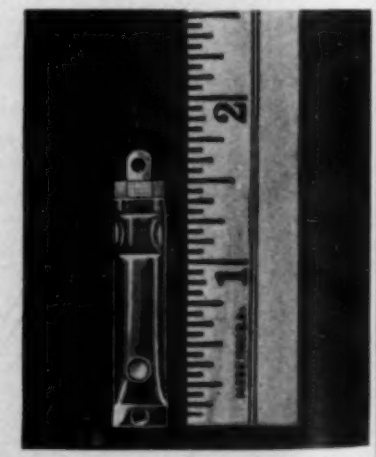


The four standard models are designed for direct motor application, but pumps can be furnished for flange, belt, spline, and other drives. Power requirements vary from fractional to 6½ hp.

Miniature Thermostat

No. 3258*—Especially designed for use in installations where dust, vibration, or moisture create operating problems, the "Mighty Mite" sealed thermostat has been announced by Mechanical Industries Production Co., 213 Ash St., Akron, Ohio.

The thermostat is preset to the customer's temperature specifications, has ⅛ in. silver contacts, and is designed to give extra safety and heat control. The standard model is preset for fixed temperatures up to 300 deg and other models are available for settings up to 600 deg. It is said to have many operating and safety applications in the electrical field including electric motors, air conditioning, refrigeration, and heating equipment.



The unit is said to be dustproof, waterproof, and tamperproof. It can be molded in rubber and various plastics and has a copper jacket which is said to make the device highly responsive to temperature. The standard model shown here is designed for use up to 300 watts, 110, 150, or 220 volts, a-c noninductive load.

A Wartime Development of Interest to Power Plant Men

The BADGER-KLEINSCHMIDT

VAPOR COMPRESSION

WATER STILL

POSSIBLE INDUSTRIAL APPLICATIONS INCLUDE USE TO PURIFY HIGH PRESSURE BOILER FEED WATER

American commanders of troops assaulting the Pacific islands never had to worry about water for their men.

Always at hand was an unlimited reservoir . . . *the sea.*

The link between the salty Pacific and pure drinking water was a distillation unit so efficient that a gallon of fresh water was obtained from the same heat input needed to bring a quart of water to the boil on a kitchen stove.

The unit was . . . ***the Badger-Kleinschmidt Vapor Compression Water Still,*** developed by Dr. R. V. Kleinschmidt of Arthur D. Little, Inc. and manufactured by E. B. Badger & Sons Co., Boston, Mass.

A major problem in designing the unit was the selection of materials. Combat use permitted a minimum of maintenance.

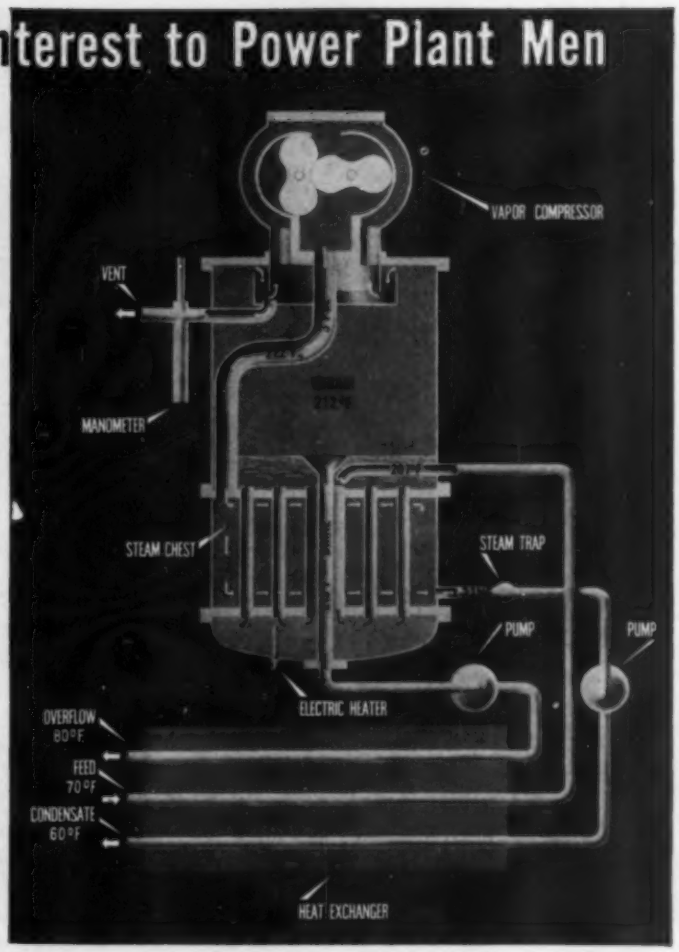
To counter the abrasive and corrosive conditions, nickel alloys were used throughout. For example, all sheet metal parts were made of a copper-nickel alloy. All nuts, bolts, studs, tie-rods, piping and other fittings were Monel.

With nickel alloys on the job it was no wonder that reports came back from the Pacific telling of Badger-Kleinschmidt stills operating smoothly even after their steel framework and housing had almost been completely eaten away.

That's why E. B. Badger & Sons Co. plans to continue using Monel in industrial vapor compression stills.

You always build-in EXTRA performance when you use nickel alloys for equipment to handle steam or water.

THE INTERNATIONAL NICKEL COMPANY, INC.
67 Wall Street, New York 5, N. Y.



OPERATING PRINCIPLE

THE VAPOR COMPRESSION STILL'S conservation of heat is a close approach to perpetual motion. Feed water intake is through a heat exchanger. Sandwiched between concentric pipes carrying hot condensate and brine overflow, the feed water is raised to 207° F. Passing to the steam chest, it circulates through tubes surrounded by compressed steam at 222° F. This boils the water. The generated steam then goes to the compressor where it in turn is boosted to 222° F. Passing into the steam chest, it gives up most of its latent heat and boils new feed water. Then it passes through the heat exchanger and emerges as potable distillate.

In diesel-powered units, the exhaust supplies all the heat. In electric units, a separate electric heater is used. Thermal efficiency is 15 times that of ordinary single-phase stills.

TWO PUMPS are used on every B-K still. Many units are equipped with Warren SED vertical pumps. The SED, manufactured by WARREN STEAM PUMP CO., Warren, Mass., has a 1¼" Monel shaft and a "K" Monel shaft sleeve.

A PORTABLE B-K STILL used by the Army, Marines and Seabees. Fixed installations were aboard submarines and other Navy craft. E. B. BADGER & SONS CO. is ready to make stills up to capacities of 100,000 gallons per day. With these large-scale models available to economically distill high-pressure boiler feed water, boiler corrosion may well be licked.

NICKEL (INCO TRADE MARK) ALLOYS

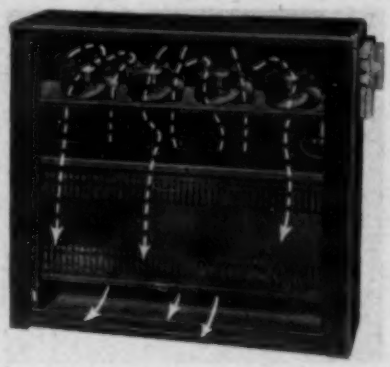
MONEL* · "K" MONEL* · "R" MONEL* · "KR" MONEL* · "S" MONEL* · INCONEL* · NICKEL · "L" NICKEL* · "Z" NICKEL*

*Reg. U. S. Pat. Off.

Air Conditioning Unit

No. 3259—A new air conditioning unit, the "Amcoil Comfortaire" conditioner, has been patented by American Coils Co., 25-27 Lexington St., Newark 5, N. J., and is now available in two floor models for homes, shops, offices, etc.

The unit consists primarily of a cooling coil which is located inside an enclosure and is designed to create a low vapor pressure area. Dehumidification, as provided in this unit, is based on the fact that vapor pressures tend to equalize. The moisture in the entering air is attracted, through small openings in the coil enclosure, to this low vapor pressure area where condensation occurs. Air which has been relieved of some of its moisture but which has not entered the enclosure, mixes below the coil with a smaller amount of cooled air which entered the coil chamber. The air mixture is then supplied to the room being conditioned.

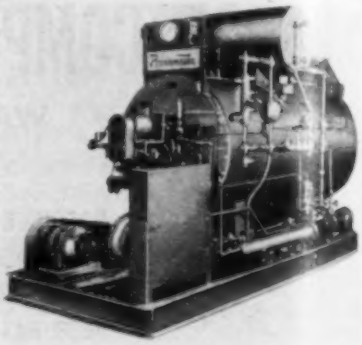


The manufacturer states that an incidental economy feature of the conditioner is the use of a smaller condensing unit using less horsepower, since, with the principle employed, it is not necessary to cool all of the air to its dew point temperature.

Commercial and Industrial Steam Generator

No. 3260—The "Powermaster" automatic steam generating unit is now in full production at the plant of Orr & Sembower, Inc., Reading, Pa.

Units are designed for both light and heavy oil operation. Small and medium sized generators use No. 3 or lighter oil, and the larger units operate with No. 5 or 6 fuel oils. Boiler capacities range from 15 to 150 hp and thermal efficiencies of approximately 80 per cent are claimed to be maintained in everyday operation. The smaller units are equipped with an electric spark ignition system and the larger units incorporate an electric-gas ignition system together with both electric and steam oil preheaters (for use with Nos. 5 and 6 fuel oil).



This packaged unit, which is provided with controls, condensate return tank, and boiler feed pump, is constructed in accordance with ASME specifications. Standard equipment is wired for 220 volt, 3 phase, 60 cycle current.

Announces Production Plans

No. 3261—Production of air conditioning and industrial refrigeration equipment during the next 12

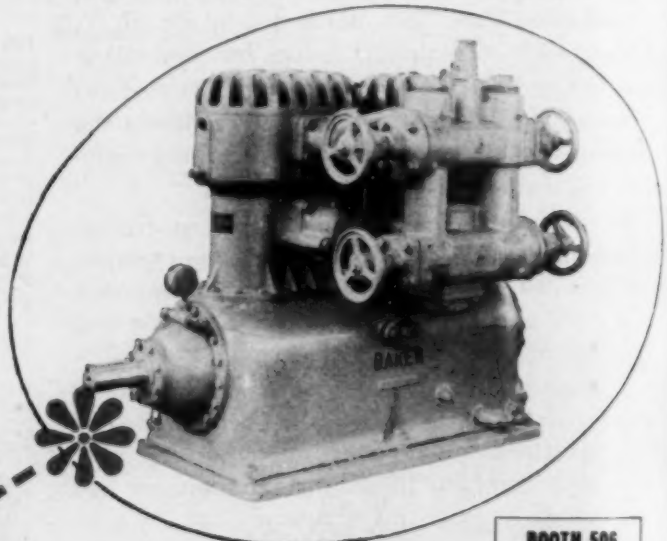
Baker PROMISED···AND NOW

···at the All-Industry Show in Cleveland
Oct. 29th thru Nov. 1st

Baker presents the new Series "F" Compressors

Greater Capacity
with Smaller Size

No longer a laboratory dream.
Production scheduled for 1947.



BOOTH 506
ALL-INDUSTRY
SHOW

The Series "F" is the result of months of intensive laboratory testing.

Baker
ICE MACHINE COMPANY, INC., OMAHA
MANUFACTURERS OF REFRIGERATION AND AIR CONDITIONING EQUIPMENT SINCE 1905

what's your need in SIZE?

Globe seamless steel tubing is made hot finished and cold drawn in alloy and carbon steels in sizes from ½ inch to 6⅝ inches outside diameter.

Globe seamless stainless steel tubing is available in tube sizes from ½ inch to 6⅝ inches outside diameter and in pipe sizes ⅛ inch to 6 inches, standard, extra strong and double extra strong weights.

Gloweld (electric welded) stainless steel tubing may be had in sizes ranging from ⅜ inch to 4 inches outside diameter inclusive, and in standard weight pipe sizes ⅛ inch to 2 inches, inclusive.

Your tubing needs may lie somewhere within the above ranges — whatever your requirements, Globe is qualified by experience and facilities to supply you with tubing of the quality and uniformity you demand.

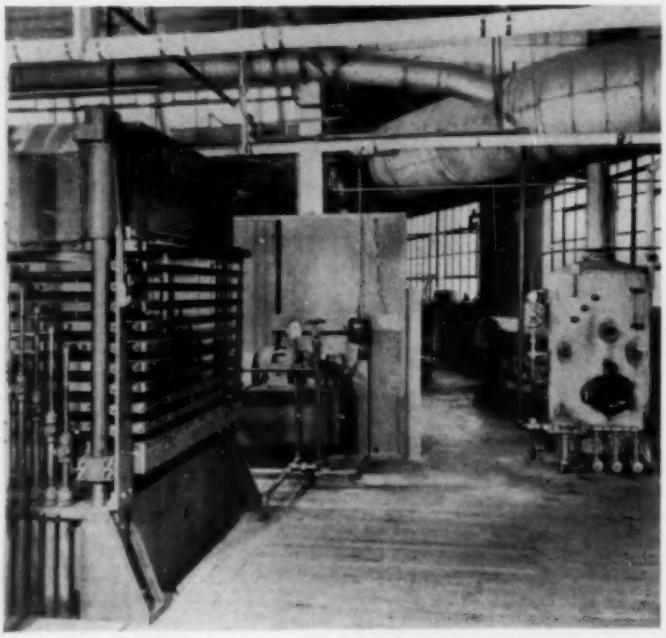
GLOBE STEEL TUBES COMPANY, Milwaukee 4, Wisconsin

GLOBE TUBES

★ STAINLESS STEEL TUBES ★ PRESSURE TUBES ★ GLOBEIRON TUBING ★ GLOWELD TUBES
★ CONDENSER AND HEAT EXCHANGER TUBES ★ MECHANICAL TUBING

5025

Heating Contractors:
How to
"Condense Costs"



"Cost Condenser"— McKee 8 H.P. "Steamboilerplant" System for a Veneer Press.

Install McKee
"STEAMBOILERPLANTS"

When you install McKee "Steamboilerplants" you boil-down costs two ways — on installation — on operation.

A complete factory-built unit, you'll find them easy and economical to install — just hook-up to the gas, water and supply lines. And remember, the entire unit is McKEE. Entire responsibility for its satisfactory operation rests with us.

McKee Eclipse
ECLIPSE FUEL ENGINEERING CO.
767 SO. MAIN STREET • ROCKFORD, ILLINOIS
Engineers in all principal cities

months at the B. F. Sturtevant Co., Div. of Westinghouse Electric Corp., Damon St., Hyde Park, Boston 36, Mass., is expected to be more than double that of the best pre-war year.

According to G. C. Derry, vice president and general manager of the division, plans are also being made for stepping up the manufacture of mechanical draft fans for power stations and fans for industrial plants during the coming year. Expansion in these two fields, as well as in the rapidly growing transportation field and in many others concerned with air handling, is expected to increase the division's production force by 50 per cent and the sales and engineering staff by 30 per cent. The current backlog of orders now totals approximately 14 million dollars.

Boiler Sealing Compound

No. 3262—A boiler powder for sealing leaks is offered by X Laboratories, Inc., 25 W. 45th St., New York 19, N. Y. as a new twin companion to the company's boiler liquid.

The highly concentrated powder is poured into the boiler through the safety valve tapping where it dissolves and circulates, or it may be mixed first with hot water. It is said to be especially effective against casting failures and sand holes, to seal the leak from the outside in, and to provide a seal which is undamaged by expansion and contraction. The powder is made from special soluble gums and, according to the manufacturer, does not contain sawdust, pulp, cement, shellac, solder, water glass, or flaxseed meal.

Combination Return and Supply Air Diffuser

No. 3263—The "Agitair RS-42" diffuser combines the features of air supply and return. It is designed to permit both supply and return ducts to be run on the same plane with separate connections at the diffuser and is offered by Air Devices, Inc., 17 E. 42nd St., New York 17, N. Y.

In contrast to circular diffusers this unit is square or rectangular in shape. It is said to require less head room than any other ceiling type fixture and to eliminate the necessity for special cutting and sealing to prevent air leakage. It is available in a variety of sizes and patterns with diffusion control.

Pneumatic Atomizing Nozzle

No. 3264—A new large capacity pneumatic atomizing nozzle is now available for ½ in. pipe connections. This nozzle is manufactured by the Spraying Systems Co., 4033 W. Lake St., Chicago 24, Ill.

Capacities of 20, 40, or 60 gph are provided by these nozzles, which are of brass or stainless steel. Built to operate with compressed air, although other gases or steam can be used, they are of the internal mixing type. Illustrated is unit with shut-off needle which is optional.

"Be it ever so humble . . ."

Somehow you *know,* without being told, that the author of "Home, Sweet Home" was an American . . .

For the simple beauty of his song so exactly expresses the love which Americans have for *home.* An attitude, both strong and reverent, born in the cabins of pioneer ancestors and guarded zealously through generations that followed. From American hearthstones the spark of independence was fanned to quenchless flame, and a succession of great men and women emerged to carry its light abroad in the land.

To people who thus cherish the *ideal* of home, the expression of its *physical form* is no less important. So American homes have become the wonder of the world! Here, the home of the Colonel's lady and Judy O'Grady differ in size, location and pretension, but seldom in facilities for necessity or convenience.

One development, perhaps more than any other, makes this possible . . . the invention and mass production of *steel pipe.*

Yes, *steel pipe makes it possible!* The conveyance of fresh, pure water from its source, however distant, to and through the home . . . for drinking, cooking, bathing, laundering, cleaning and sanitation. For providing conventional heating or the advantages of the newly developed *radiant* heat. For cooling in summer. For fire protection . . . for a hundred-and-one uses.

Durable, reliable, economical . . . *steel pipe* makes these comforts of home available to *all!* That's why 90% of all home piping is *steel piping.*

The interesting story of "Pipe in American Life" will be sent upon request.

Committee on
Steel Pipe Research
OF
AMERICAN IRON AND
STEEL INSTITUTE
350 Fifth Avenue, New York 1, N. Y.

STEEL PIPE MAKES IT POSSIBLE!

. . . better living through pipes of steel for plumbing and heating purposes.

NEW BOOKS & REPORTS

New Fractional Horsepower Motor Standards Announced

A broad new program of standardization for fractional horsepower motors, designed to reduce production costs, insure efficiency and proper application in use, and result in long term savings to customers, has been announced by members of the motor and generator section of the National Electrical Manufacturers Association.

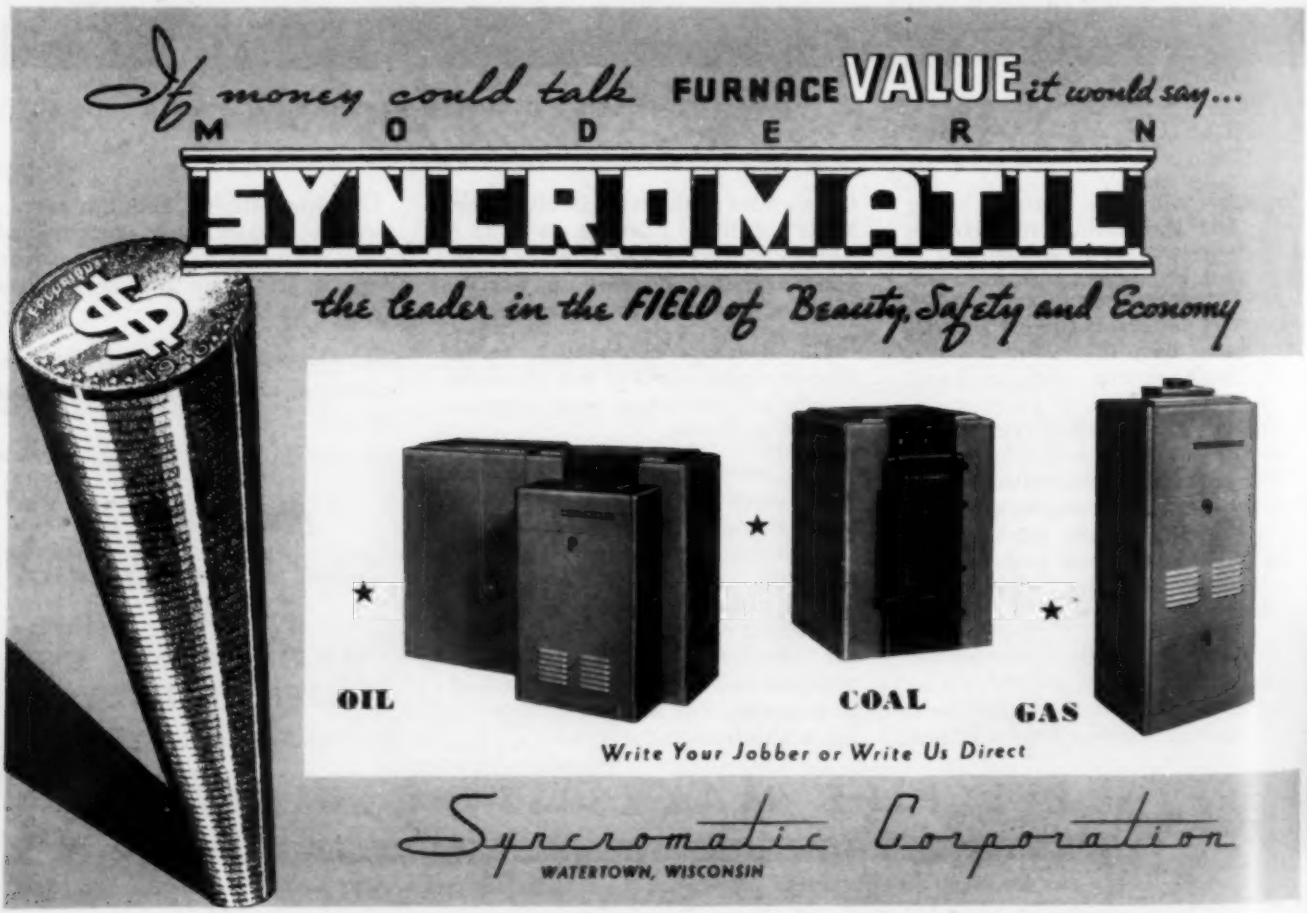
Due to the increasing number of uses for small motors, the new NEMA standards are of importance to allied manufacturing groups, as well as to application engineers, electrical contractors, power suppliers, and others in appraising motor performance in terms of nameplate rating and motor application.

The value of standardization as a key factor in obtaining performance interchangeably in application and maximum production efficiency has been recognized by motor manufacturers virtually since the inception of the business, according to L. C. Spoor, vice chairman of the fractional horsepower subdivision of the motor and generator section of NEMA. Standardization in the general motor field was initiated as early as 1908, he says, and over a period of years has proved to be a powerful factor in establishing high quality products and reducing overall costs.

During the war the demand for small motors showed a phenomenal increase, and the backlog of demand today is among the heaviest of all electrical products. Prior to the all-time peak demand brought on by the war and the existing need for appliances, many special lines of motors were built according to individual specifications, resulting in multiplicity in design. The tremendous shortage of motors is one of the determining factors, Mr. Spoor says, in developing standards which will facilitate maximum production.

The new standards provide specific definitions of motor rating and performance in coordinated terms of horsepower rating, speed, breakdown torque, and service factor. In formulating the new standards, the motor manufacturers felt that a clearly defined and generally accepted method of evaluating motor performance was essential in order to assure intelligent design, manufacture, and use of small power motors. The fundamental points covered in the standards include not only this new basis of rating, but also previously standardized locked rotor or starting currents of motors. This is but the first phase in the new program of standardization, and will be followed later this year by other items of standardization such as dimensions, and application standards for hermetically sealed motors, belt drive refrigeration compressor motors, washing machine, stoker, oil burner, belted fan and blower motors, shaft mounted fans and blowers, and gasoline pump and jet pump motors.

The standards will thus be of major interest to a wide range of users who may, as a result, be sure that the stamping on the motor nameplate is an accurate designation of the article he is purchasing and will thus obtain increased return on motor investments



Men with ideas

get AHEAD!

Men get IDEAS at the Air Conditioning Show!

IT'S COMING — the 7th International Heating and Ventilating Exposition—largest ever held and first in seven years. Here is your opportunity to familiarize yourself with the newest ideas, products, and people in the industry. It will give you the chance to "catch up" on new trends, to discuss your problems with engineering specialists at the exhibition booths, to revitalize your thinking.

The more fully informed you are on the newest and best equipment available, the more successfully you can plan efficient, economical installations. On display at the Exposition will be all types of heating, ventilating, air conditioning, and related equipment—some excitingly new, all interesting . . . all a part of the up-to-date picture *you* need.

A wealth of helpful information awaits architects, industrial engineers, consulting engineers, manufacturers, contractors, distributors, building owners and operators—*anyone* concerned with the efficient application of heat, ventilation, and conditioned air to all types of buildings—industrial, commercial, residential.

Mark the date on your calendar. It's an event you can't afford to miss!

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7th INTERNATIONAL HEATING & VENTILATING EXPOSITION

The Air Conditioning Exposition

LAKESIDE HALL, CLEVELAND, OHIO • JANUARY 27-31, 1947

Under the auspices of the American Society of Heating & Ventilating Engineers

Management of International Exposition Co., Grand Central Palace, N. Y. 17, N. Y.

Only RIDGID guarantees you a repair-free housing . . .

UNCONDITIONAL GUARANTEE
If this Housing ever Breaks or Distorts we will replace it Free
THE RIDGE TOOL CO.
ELYRIA, O.

SIZES 6" TO 60"

RIDGID *Compound Leverage Wrench.*

● You get more for your money with RIDGID pipe wrenches. That special design housing simply won't warp or break in any normal use, however strenuous—as millions of users know. No laid up for housing repairs, no bother and expense. No binding of adjusting nut—it spins easily to size. Alloy jaws take hold and let go instantly. Handy pipe scale on hookjaw, comfort-grip I-beam handle. A wrench it's a pleasure to work with—ask your Supply House.

RIDGID
WORK-SAVER PIPE TOOLS
THE RIDGE TOOL COMPANY • ELYRIA, OHIO, U. S. A.

through proper application, freedom from motor trouble and longer motor life. As a result of better standard definitions, the machinery or appliance manufacturer, for example, can obtain proper motors from all suppliers without having to go through exhaustive engineering tests for each application or make of motor. This is also important from the standpoint of the ultimate purchaser of machines or appliances who has to make a sizeable investment and expects performance and long life from the appliance.

In the past, Mr. Spoor points out, the horsepower stamped on a fractional horsepower motor plate has not always been a true indication of the motor's load-carrying ability since no adequate standard had previously been established to define horsepower rating in terms of speed and torque.

In formulating these standards, attention was also given to factors which will permit selection of proper control equipment and wiring. Effort has likewise been made to define the standards in terms which will afford maximum freedom in design progress.

Hydraulics Textbook Stresses Fundamentals

Elementary Mechanics of Fluids, by Hunter Rouse, professor of fluid mechanics and director, Iowa State Institute of Hydraulic Research, State University of Iowa, is an excellent addition to the meager but rapidly expanding literature on the general subject of mechanics of fluids, or, as other authors have chosen to call it, fluid mechanics. This book develops in a rational and progressive manner the fundamental principles needed in the application of the general principles of mechanics of fluid to practical engineering problems. While it is designed primarily as a textbook on the subject, it will be a valuable addition to the library of the practicing engineer who is interested in keeping up with the developments which are taking place in this important field.

While it is elementary in the sense that it can be used as a first text in the subject, it gives a complete development of all the applications covered. It requires no further mathematics for its understanding than that given in the ordinary engineering curriculum. It is a thoroughly basic book continually going back to general principles. To the engineer who is interested in application of this book to his current problems, sufficient examples are given to serve as a guide in such confusing matters as units and applications of formulas. This book does an excellent job of developing the subject from the basic equations of mechanics and definitely is not a hydraulic textbook which has been revised or combined with a discussion on fluid mechanics. The text contains many very excellent photographs showing many of the phenomena which are explained in the text. These are unusually well selected and are excellent representatives of application of the subject matter to real problems. The basic nature of the book recommends it as a permanent reference book in the practicing engineer's library.

The text is published by John Wiley & Sons, Inc., 440 Fourth Ave., New York 16, N. Y., contains 276+xii pp., is cloth bound, and is priced at $4.—Reviewed by E. N. Kemler, head, engineering research division, Southern Research Institute.

MEETINGS & CONVENTIONS

Refrigeration Service Engineers To Hold Convention in Cleveland

Meeting in Cleveland for its 9th annual convention, October 26 to 29 at the Hollenden hotel, the Refrigeration Service Engineers Society expects to stage its largest annual meeting for the group now numbers over 6500 members with 105 local chapters. The four-day business and educational meeting will immediately precede the All-Industry Refrigeration and Air Conditioning Exposition to be held at the Cleveland Auditorium.

The convention will be formally called to order Saturday afternoon, October 26, by Acting President Clarence Buschkopf, Beaver Dam, Wis. The morning and afternoon session on the following three days will be devoted to educational programs during which various talks on technical subjects will be given. Some of the topics scheduled will be on modernization and replacement of obsolete equipment, the two-temperature refrigerator, developments in shaft sealing and thermal expansion valves, hermetic units, preventive maintenance on air conditioning equipment, and servicing ammonia compressors. One of the highlights of the program will be conducted tours through various manufacturing plants and refrigeration installations.

Society headquarters are at 433 N. Waller Ave., Chicago 44, Ill.

REMA Sponsors Refrigeration Show

Exhibits covering all types of refrigeration, air conditioning, and frozen food equipment will be on display at the 4th All-Industry Refrigeration and Air-Conditioning Exposition in the Cleveland Auditorium, October 29 to November 1. The show, which will be the largest ever held by the industry, is sponsored by the Refrigeration Equipment Manufacturers Association and will also include displays of frozen food processing equipment, wrapping materials, insulating materials, and many other related products.

During the week of the show the following associations will hold meetings: Refrigeration Equipment Wholesalers Association, Refrigeration Equipment Manufacturers Association, Refrigeration Service Engineers Society, National Frozen Food Locker Association, Frozen Food Locker Manufacturers and Suppliers Association, and the National Association of Refrigeration Contractors.

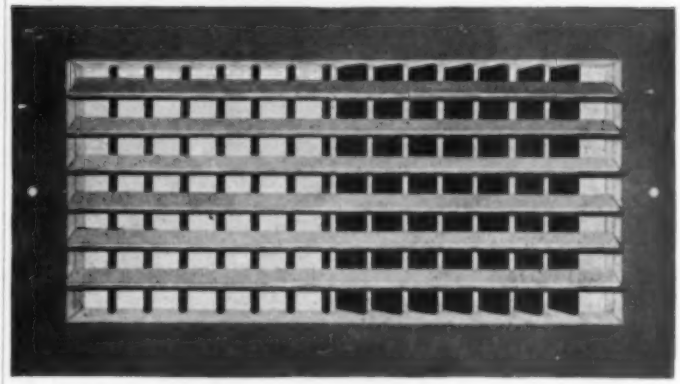
Exposition headquarters are at 1107 Clark Bldg., Pittsburgh 22, Pa., also headquarters of REMA.

Public Health Meeting to Include Sessions on Industrial Hygiene

The 74th annual meeting of the American Public Health Association and meetings of related organizations will be held in Cleveland, November 11 to 14.

The industrial hygiene group will hold its first session on Tuesday, November 12, at 2:30 p. m. T. L. Hazlett, M.D., will preside and the subjects of the papers to be presented will include The Value of Industrial Hygiene, Education in Industrial Health, and

HIGH VELOCITY OUTLETS



HIGH VELOCITY OUTLET

Adjusted for Down Throw and to One Side

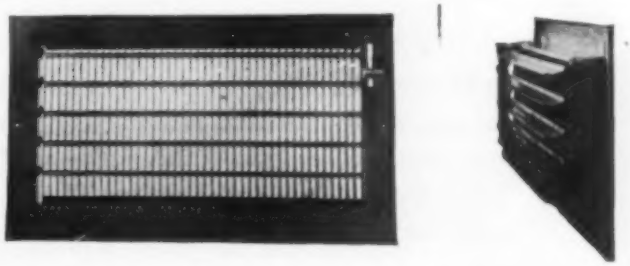
Style "DDH" illustrated above is one of eight variations of our high-velocity outlet—each bar individually adjustable with key furnished—with or without volume valves. Supplied with baked prime coat and sponge rubber gasket.

This is a heavy, attractive outlet made in all sizes, with matching fixed-bar down-deflecting return grille. Prices are competitive.

Prompt shipment of this line is available.

MANUFACTURERS OF ROOM COOLERS

We are in a position to supply variations of the High Velocity Outlet illustrated above, curved to follow the contour of your cabinet, or straight. Your inquiry is invited for prompt, helpful information.



Style 74—Register—Wall or Baseboard. This Register utilizes 1" multiple-dampers to control volume and vertical direction. Multiple dampers may be set so as to obtain up, straight, or down deflection, as well as complete shut-off. The face is the same as all others of the "70" line—permitting air reflection right or left by adjusting front blades with key furnished. Blades are ¼" center to center, and ¼" in depth. Complete with rubber gasket, screw holes, prime coat. This is an attractive, well-constructed register, available promptly.

For immediate quotation and literature, wire, write or Telephone your inquiry to Bloomfield 2-2345

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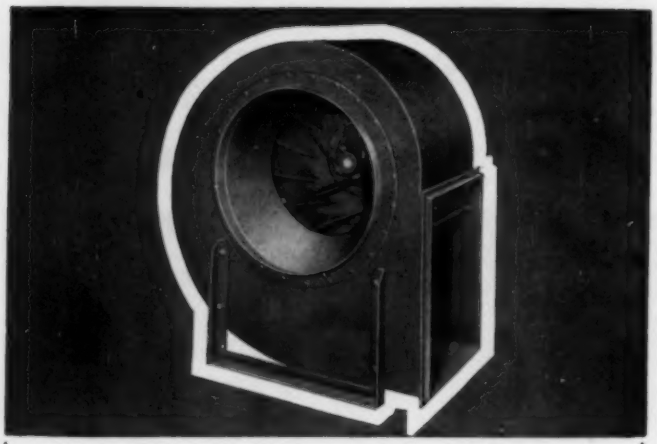


'GENERAL' MULTIBLADE EXHAUSTERS

Exactly adapted to the Exacting requirements of Heating, Ventilating and Air Conditioning Services

Forward and Backward Curved Blades
In all sizes, wheels 12 to 72 in.

And forward curve "Juniors" with wheel diameters 6 to 10

For your files, on request: Bulletin SC-102, with complete performance tables, dimensions, etc.—52 big pages.

GENERAL BLOWER CO.

"Lungs for Industry"

Factory Offices: **Morton Grove, Ill. 8601 Ferris Avenue**

District Sales: **Chicago 10, Ill. 502 N. Dearborn St.**

Sales Representatives in Principal Cities

Lessons Learned in the Services. Papers scheduled for the second session on Wednesday the 13th will deal with such topics as the National Workmen's Compensation Conference Committee, union contracts and industrial hygiene, aviation medicine, and industrial hygiene research.

Association headquarters are at 1790 Broadway, New York City.

AWS Schedules Many Technical Papers for Annual Meeting

A total of 80 technical papers has been scheduled for presentation at the 24 sessions of the 1946 annual meeting of the American Welding Society. This 27th annual meeting will be held in Atlantic City on November 17-22.

Among the many papers will be some on welding research, resistance welding, pressure welding, cutting, weldability, electrodes, production welding, welding pressure vessels and storage tanks, hard facing, and high alloys. In addition several papers will be presented covering a variety of subjects such as arc welding of cast iron with nickel electrodes, flame-hardening, and plant maintenance.

W. F. Hess, president of the Society will preside at the annual dinner on November 21.

Society headquarters are at 33 W. 39th St., New York City.

ASME Annual Meeting to Coincide With Power Show

The 1946 annual meeting of the American Society of Mechanical Engineers, 29 W. 39th St., New York, will

Cut Your Heater Costs Through Proper Heat Distribution

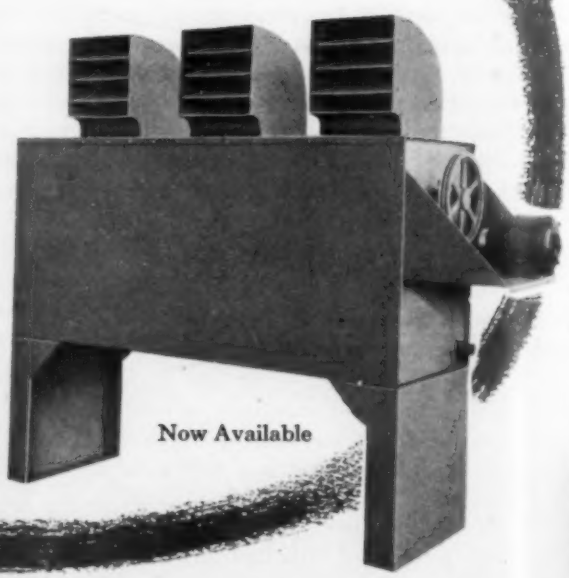
with AIRTHERM UNIT HEATERS

(Blower Fan Type)

Built to give continuous service in factories, garages, warehouses and other types of large area construction, the Airtherm Blower Fan Type Unit Heater will deliver heat to every corner.

Install Airtherm high velocity Unit Heaters in your plant and cut heating costs through proper heat distribution throughout your plant. Floor-mounted or suspended models.

Write for Bulletin 401



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AIRTHERM MANUFACTURING COMPANY

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All over America leading Insulation Contractors install NOVOID

Interlocking Tile Corp. of Seattle, Wash., are one of the outstanding insulation contractors of the Northwest. They have insulated cold storage warehouses for the Army, the Navy, and many industrial firms. Shown at top is the new plant of the Bellingham Cold Storage Company, for which this contractor supplied and installed 13 carloads of Novoid Corkboard. Below it is one of the free-standing Novoid Corkboard partitions under construction.

★ ★ ★

READY NOW! At your nearby Novoid contractor's you'll find Novoid Cork Pipe Covering for every standard-size pipe, and in a variety of thicknesses. You can now get prompt delivery and installation of this money-saving insulation.

Novoid Covering is the moulded rigid insulation that efficiently reduces your cost of refrigeration. It snugly hugs pipe and fittings of every size and shape, does not sag, does not absorb moisture or odors, and is long-lasting.

For complete facts about Novoid Corkboard, Pipe Covering, and sundries specially developed to make low-temperature insulations most efficient, write to Cork Import Corporation, 39 Park Place, Englewood, New Jersey.

NOVOID INSULATION

CORKBOARD · PIPE COVERING

You thread small pipe with least effort with this tough little RIDGID No. 0R

● Speedy and a worksaver, when you want to cut perfect threads on ⅛" to 1" pipe. This smart steel-and-malleable internal ratchet threader has precision-made heat-treated tool-steel dies, each factory tested . . . for smooth fast threading. Die heads snap in from either side, can't fall out. No special dies needed for close-to-wall work. No. 0R, ⅛" to 1"; No. 11R, ⅛" to 1¼." You'll like these durable efficient RIDGIDs for small pipe. Ask your Supply House.

Chasers easily reverse for close-to-wall threads.

RIDGID

WORK-SAVER PIPE TOOLS

THE RIDGE TOOL COMPANY · ELYRIA, OHIO, U. S. A.

WILLIAMS
SUPERIOR DROP-FORGED TOOLS
"VULCAN"
Drop-forged
CHAIN PIPE VISES

Above: "VULCAN". 4 sizes for pipe 1/8 to 8 inches.

At right: "VULCAN SUPERIOR", with reversible jaws and adjusting handle on top. 2 sizes for pipe 1/8 to 4-1/2 inches.

"Vulcan", the original chain pipe vise, is made entirely of tough, wrought steel ... no cast parts whatever. The dropforged jaws are of saw-tempered steel for file sharpening . . . chains are of the same high quality as Williams' "Vulcan" Tongs. Fully guaranteed, and sold by Industrial, Plumbing and Oil Field Distributors everywhere.

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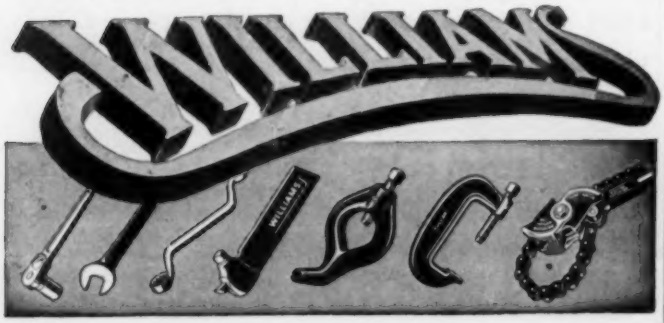

be held, December 2 to 6, in that city. The 7th National Exposition of Power and Mechanical Engineering, better known as the National Power Show, will be held in Grand Central Palace, New York, December 2 to 7.

Though highly diversified, the principal exhibits at the show will cover the transformation of energy in fuel into power. Key classifications of displays start with pumps and conveyors for handling liquid and solid fuels and run on through boilers, turbines, burners and stokers, blowers and exhaust fans, valves and piping, traps, blow-downs, liquid level indicators and controls, as well as auxiliaries of many kinds.

First established in 1922, the show is being conducted by the International Exposition Co., Grand Central Palace, New York.

ASHVE to Meet in Cleveland And to Sponsor Exposition

In addition to sponsoring the 7th International Heating and Ventilating Exposition, to be held in Lakeside Hall, Cleveland, the American Society of Heating and Ventilating Engineers will hold its 53rd annual meeting in that city. Both the annual meeting and the exposition are scheduled for the last week in January 1947.

The International Exposition Co., Grand Central Palace, New York, is managing the show with general planning and policies being formulated by an advisory committee of industrial and professional leaders under the chairmanship of A. J. Offner, president of ASHVE whose headquarters are at 51 Madison Ave., New York 10, N. Y.

EFFICIENT
ECONOMICAL

De Luxe type WK Pressure Actuated Water Regulating Valves for Freon, Sulphur or Methyl, are pilot operated, modulating. Standard adjustable opening range from 50 to 150 lbs. Factory set to open at 90 pounds. Precision engineering and individual testing for low cost, satisfactory performance. Available in sizes of ¾ to 2 inches FPT. Simple adjustment--easily serviced.

Other sizes and types are also available.

Electrimatic
2100 INDIANA AVE. CHICAGO 16, ILL.

ZALLEA self-equalizing Corrugated Expansion Joint installed on 100 lb. steam line at State Hospital, Norristown, Pa.

CONVERTED into years, that takes us back to 1933. That's the year the New York Giants won the World Series . . . the Chicago World's Fair opened . . . Wiley Post flew the *Winnie Mae* around the world. During that year this ZALLEA Corrugated Expansion Joint was installed—and it's still doing the same "bang-up" job *today!*

It's the quality ZALLEA builds into every expansion joint that makes them last . . . even in the severest service. There's *no* packing to deteriorate . . . *no* maintenance required. Once properly installed, they can be forgotten, with the full assurance that they will do the job intended.

Be sure! Always specify and *demand* ZALLEA Corrugated Expansion Joints.

Zallea Corrugated Expansion Joints are made in non-equalizing, self-equalizing and duo-equalizing types, depending upon the conditions under which they must operate . . . of copper, stainless steels and other corrosion-resistant alloys . . . diameters from 3" upward . . . traverses up to 7½" . . . for pressures from vacuum to 300 psi . . . for temperatures from sub-zero to 1600° F. Let us quote on your requirements.

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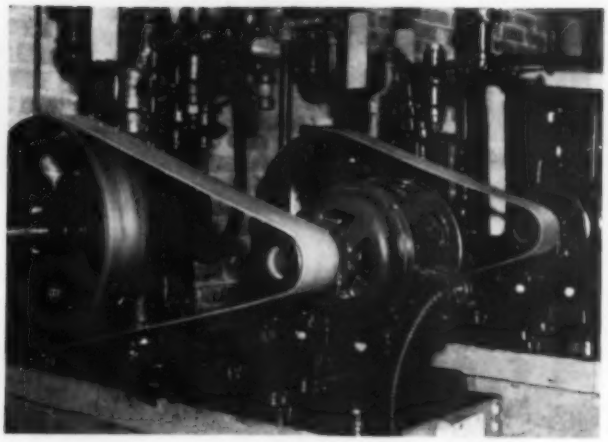
Specify and demand ZALLEA Furnace-Annealed Expansion Joints



Tannate-Rockwood

PARTNERSHIP IN POWER

The *Rockwood* drive uses the simplest form of power transmission—a strong, flexible belt (be sure it's Tannate) and by application of correct engineering principles makes it the most practical type of short-center drive ever designed. The motor is mounted on a free-moving pivot so that its weight may *automatically* maintain the *correct belt tension* necessary to insure *maximum efficient flow of power* at all times.

The *Tannate* leather belt has not only a very high coefficient of friction but also a great pliability that helps keep machines running at top speeds.

Get this most efficient drive for your machines.

ESTABLISHED 1702

J. E. RHOADS & SONS
35 North Sixth Street, Philadelphia 6, Pa.
NEW YORK • CHICAGO • ATLANTA

CLOG-PROOF SPRAY NOZZLES

ROTOJET

Rotojet spray nozzles are the ultimate in simplicity and efficiency. They provide excellent atomization through the high centrifugal force developed by the flow of the liquid. There are no moving parts, no adjustments. The action set up within the nozzle keeps it clean and clog-proof. Extra metal at points of wear gives Rotojet exceptionally long life. Rotojet nozzles are available with orifices from 1/16" to 1-13/16".

There is a Rotojet Nozzle for every spray job.

WRITE NOW
For Bulletin No. 450

Bulletin No. 450 gives you 8 pages of specifications, capacity tables, industrial applications, and other valuable information about Binks Standard Spray Nozzles. Drop a card in the mail today for your free copy of this helpful booklet.

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RECENT TRADE LITERATURE

For your convenience in obtaining copies of these bulletins, see coupon on page 159. If you write direct to the manufacturer, describe carefully what literature you want, as the number given first in each item is for use only when sending requests to Heating, Piping & Air Conditioning.

Baseboard Heating System

No. 6293—A one pipe, hot water baseboard heating system is described in a new bulletin (No. 639) released by the C. A. Dunham Co., 450 E. Ohio St., Chicago 11, Ill. In this system a finned ferrous pipe, 1 in. diameter, is installed behind a specially designed baseboard which contains hidden louvers. According to the manufacturer the baseboard is easy to clean, has a removable cover, and extends down to the floor. The bulletin includes data for sizing the finned sections and outlines the recommended design procedure.

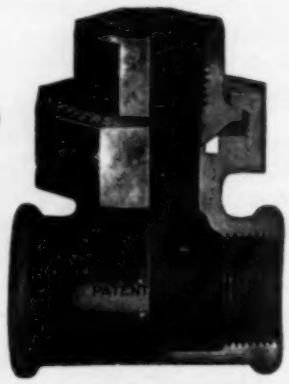
Blowers, Fans, and Exhausters

No. 6294—A new bulletin describing the "Lungs for Industry" line of exhausters, fans, blowers, and insulation blowing machines has been issued by the General Blower Co., 8065 Ferris Ave. Morton Grove Ill.

Commercial Refrigeration

No. 6295—Lehigh Foundries, Inc., Refrigeration Div., Lancaster, Pa., has issued a series of descriptive sheets covering the company's line of air cooled compressor-condensing units in the ¼, ½, and ⅓ hp sizes. General specifications, capacities, and list prices are included.

THE UNIONS WITH THE RECESSED BRASS SEAT



JEFFERSON SPECIALTY UNIONS

Effect Big Savings in Labor

Jefferson Union Tees with union on the outlet assure labor savings and better piping jobs because they take the place of an all-female union, two nipples and an ordinary tee. Three joints are thus saved. Aavilable in All-Female and Male and Female threads.

The brass seating in these and all Jefferson Specialty Unions is an exclusive feature which, located in a recess away from the runway of the fitting, leaves a straight bore assuring unrestricted flow in the pipe.

JEFFERSON UNION CO.
601 West 26th Street, New York 1, N. Y.
Factories at
Lexington 73, Mass. Lockport, N. Y.

In Famous Restaurants Everywhere—

TRADE FRICK MARK

Refrigeration

Performs half a dozen indispensable services—conditioning air, cooling drinking water, dispensing beverages, freezing ice, making ice cream, quick-freezing foods, and holding desired temperatures in any number of rooms and boxes — for meats, fish, poultry, dairy products, fruits, vegetables, frozen foods, candy, flowers, etc.

The National Hotel at Havana uses Frick Refrigeration for half a dozen services.

Main Dining Room at the Royal Hawaiian Hotel, Honolulu.

If the restaurants in which you are interested need any of these cooling services, get in touch with your nearest Frick Branch or Distributor. Literature and estimates cheerfully furnished.

DEPENDABLE REFRIGERATION SINCE 1882

FRICK CO.

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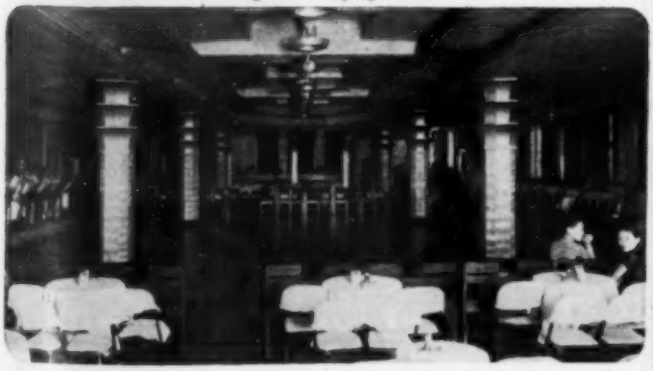
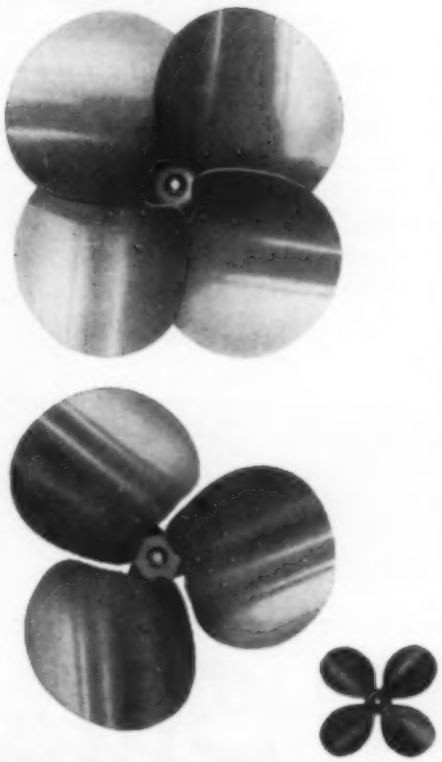
China is among the Eastern Countries that use Frick Air Conditioning and Refrigeration.



Balanced

FOR FULL AIR VOLUME



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THE NEW BURDEN 3 and 4 blade aluminum fans are two of the quietest on the market today.

Perfectly balanced, they are noted for their maximum volume of air flow. They operate smoothly and efficiently — with a minimum of horsepower.

Simplicity and ruggedness of construction assure long lasting performance at its best.

These Burden blades are suitable for nearly all ventilating and pressure type applications. Attractive in their natural aluminum and cadmium plated finish, they add immeasurably to the appearance of any product for which they are used.

Write for Folder showing complete Burden Line of Impellers.

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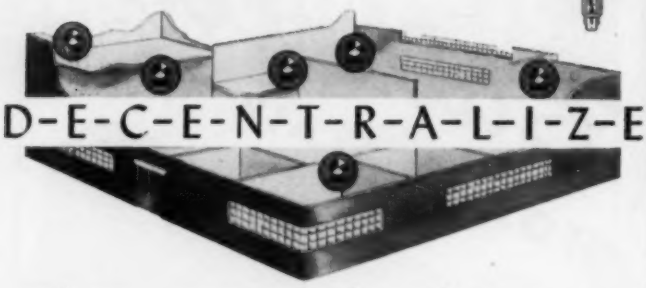
22 ways to

STEAM-PAK GENERATOR



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when you modernize . . .

When you build your new plant or modernize an old one, plan to use several *Steam-Paks* strategically located at points where you need steam. This saves piping steam from a central boiler room, gives you *uniform* steam pressure adjusted to the local demand.

STEAM-PAK GENERATORS are built in 22 models, low or high pressure, from 15 to 100 h.p., burning No. 3, No. 5 or No. 6 oil.

YORK SHIPLEY INCORPORATED

America's Most Complete Line—Industrial, Commercial, Domestic Oil-Fired Equipment

Industrial Division YORK • PENNSYLVANIA

Diesel Electric Generator

No. 6296—The Caterpillar Tractor Co. Peoria 8, Ill., has issued a 20 page booklet illustrating and describing the company's line of diesel electric generator sets which are available in sizes from 15 to 90 kw. The engines operate on the 4-stroke cycle and are equipped with either an electric or small gasoline engine starting system. Self regulating sets are available in all standard voltages up to 440, a-c and the externally regulated sets may be obtained in standard voltages up to 2400.

Electric Heaters

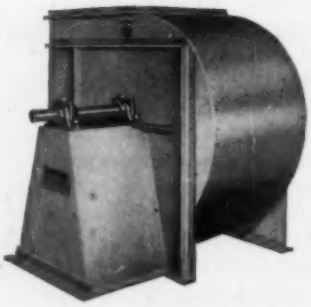
No. 6297—"Indeeco" electric blast coil and duct heaters are covered in a specification sheet (Bulletin E-97) issued by Industrial Engineering & Equipment Co., 711 S. Theresa Ave., St. Louis 3, Mo. Units are recommended for reheating and prime heating in air conditioning jobs, booster heating, space heating in offices and factories, and in industrial drying, processing, and baking. Heaters are available in capacities from 1000 to 102,000 watts. Construction features, overall dimensions, electrical data, and resistances to air flow data are included.

Electric Heating Unit

No. 6298—The "Vap-O-Lec" heating unit consists primarily of low voltage immersion type electric strip heaters which are located in a hermetically sealed steam generator. Heat transfer coils are used to heat air which is filtered and circulated through a warm air system by a centrifugal fan. The unit is described and illustrated in a new four page folder issued by Cronholm Mfg. Co., 3500 S.E. Hawthorne Ave., Portland 15, Ore.

Standardize on

MASSACHUSETTS

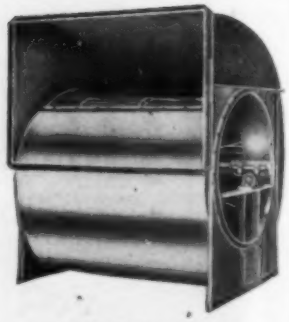


Power Fixed Backward Curve Blade Type

• Outstanding in Performance •

Quiet, efficient operation. Precision engineered. Rugged construction. Double width, double inlet. Built in a wide range of standard sizes and arrangements and in Class I or Class II design.

Rating and dimension tables available. Write for catalogs.



Squirrel Cage Type. Slow Speed Characteristic

MASSACHUSETTS BLOWER DIVISION

The BISHOP & BABCOCK *Mfg. Co.*

4901 HAMILTON AVENUE • CLEVELAND 14, OHIO

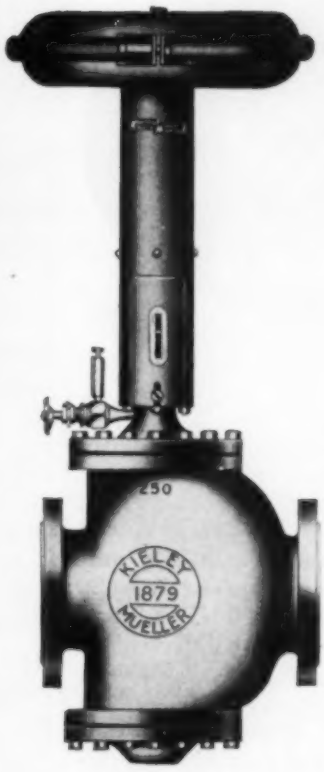
SOMETHING NEW HAS BEEN ADDED

Write for new Kontrol Motor bulletin. Send us your control problems.

KIELEY & MUELLER, INC., North Bergen, N. J.

KONTROL KIELEY & MUELLER MOTOR

SEE OUR EXHIBITS—
BOOTH 155, NAT. CHEMICAL EXPOSITION
BOOTH 158, INST. SOCIETY OF AMERICA



- **All Steel Diaphragm Motor Unit . . .** lighter, tougher, stronger, more durable
- **Boltless "Duoseal" Diaphragm Casing . . .** tight sealing, quick acting clamp ring; molded highly flexible neoprene diaphragm
- **Steel Tubular Yoke . . .** enclosing long, heat-treated, cadmium plated spring; packing gland and spring adjustment accessible through door
- **Valve Position Indicator . . .** standard equipment; no extra charge
- **High Capacity Valve Bodies . . .** unrestricted flow areas, smooth flow; available in bronze, semi-steel, cast steel, and special alloys
- **Superfinished Disc Guides . . .** top and bottom guided Bevel, Percentage V Port, and Parabolic discs; minimum friction, increased life
- **Modern Design . . .** to meet modern process requirements for better control

TALLMADGE ZONED CONTROLLED HEATING SYSTEMS

For better Heating at less cost

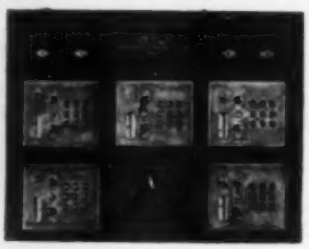


Figure 1

Figure 3

Figure 4

Figure 2

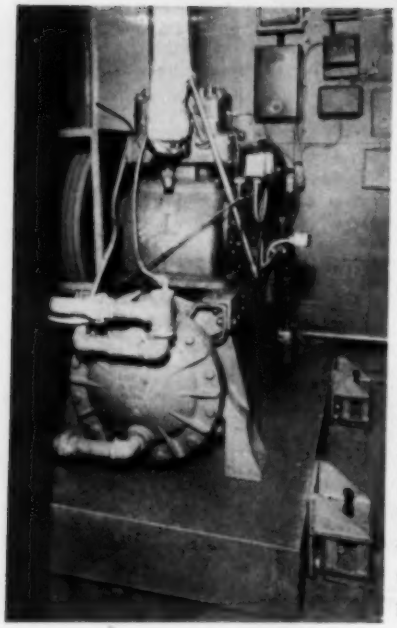
Figure 5

THE TALLMADGE equipment shown above is for a Zoned Heating System, either automatic or remote control (Figure 1). Airotherms, (Figure 2) for outside control, determine the heating requirements and set Pressure Boxes (Figure 3) to regulate the steam pressure to each zone. Zone valves (Figure 4) control the steam passing to the radiators. Orifices (Figure 5) meter the steam entering the radiators.

ADVANTAGES: Precise control of steam. Elimination of over-heating and costly waste of fuel. Low cost of maintenance. Saving on outlay for original equipment. Greater comfort to occupants due to steady heat and modulated even distribution.

WEBSTER TALLMADGE & CO., Inc. 364 Glenwood Ave., East Orange, N. J.

AIR CONDITIONING *Silenced* by KORFUND



ADJACENT to a broadcasting studio on the eighth floor of a New York building, this 2-cylinder, 2,050 lb. compressor unit with speed of 650 RPM, 10 HP motor at 1,700 RPM, is installed on 1,800 lb. concrete slab, and side-mounted on four Korfund LK/D Vibro-Isolators with Elasto-Rib pads. These support the entire unit with no disturbing vibration or noise transmission.

EVERYONE knows that broadcasting studios have to be quiet. And since most broadcasting studios today are air conditioned, Korfund Vibration Control must keep air conditioning noises *off the air*. Korfund meets this test of vibration and sound control with especially designed Vibro-Isolator Units.

Whether *your* air conditioning is in a restaurant, department store, hospital or theater, one of its benefits is quiet operation. Korfund Vibration Control is the answer to air conditioning operating disturbance. Contact Korfund today for a discussion of your vibration and noise transmission problem. No obligation, of course.

KORFUND
VIBRATION CONTROL
THE KORFUND COMPANY, Inc., 48-36 32nd Pl., LONG ISLAND CITY 1, NEW YORK

Flange Jacks

No. 6299—Flange jacks, designed to simplify and speed up the opening of flanges on pipe lines and other flanged surfaces for gasket renewal, are covered in two descriptive folders issued by T. G. Persson Co., 224 Glenwood Ave., Bloomfield, N. J. Jacks are offered for standard flanges 2 to 20 in. in diameter and for extra heavy flanges up to 12 in.

Flexible Couplings

No. 6300—A new flexible coupling, consisting basically of two hubs and a helical spring, is described and illustrated in an eight page booklet released by the Irving Flexible Coupling Co., Inc., 1516 W. Slauson Ave., Los Angeles 44, Calif. An important feature of the couplings is said to be the transmission of power along the vertical axis of the rod from which the coil was formed This is provided for by securing the ends of the springs in the hubs with locked set screws. Other features such as the absence of moving parts, permission of great misalignment, the lack of maintenance and lubrication, and the lack of bending thrust and backlash are also described. Dimension and performance data are included.

Flow Control Instruments

No. 6301—Propeller and shunt flow type meters for measuring the flow of steam, air or gas, together with venturi tubes, nozzles, orifice plates and flanges, and indicating and recording instruments are briefly described in a four page bulletin (No. 359) issued by Builders-Providence, Inc., Div. of Builders Iron Foundry, Providence 1, R. I.

The best protection is PERFECTION

Manufacturers of

Industrial Indicating
Remote Reading
and Recording
Thermometers
•
Controllers
for Time, Pressure
and Temperature
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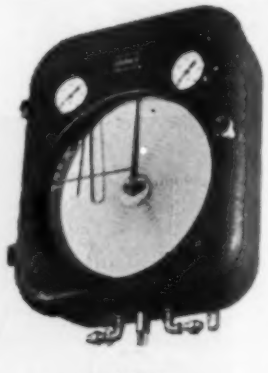
Pressure Gauges
and Recorders



GOTHAM RECORDER CONTROLLER AIR OPERATED with 12" chart

GOTHAM

Illustrated catalog H on request

GOTHAM INSTRUMENT CO., Inc.

NEW YORK
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SAN FRANCISCO

Representatives in all Principal Cities

For radiant heating

Tal Announces

Another Major Engineering First

180° Bends In One Lightning Operation

Now, with this 180° portable bender, you can thumb your nose at your problems of getting fittings and hiring good welders . . . . for with this carry-to-the-job machine, you can bend any wrought iron or steel pipe 3/8" to 3" in one fast moving operation. You reduce the need for welds and fittings 40 to 80%; do in minutes, work that required hours of time before.

Quality engineering has made Tal the bender preferred by hundreds of heating and plumbing contractors everywhere who have already swung to this new way of handling pipe by lightning bending. Use it for radiant heating installations — *and for all other plumbing and heating work too.* Write today for factual data bulletin on this great time saving, money-making tool.

HYDRAULIC PORTABLE TAL PRESTAL

Tal Prestal Bender, Inc.

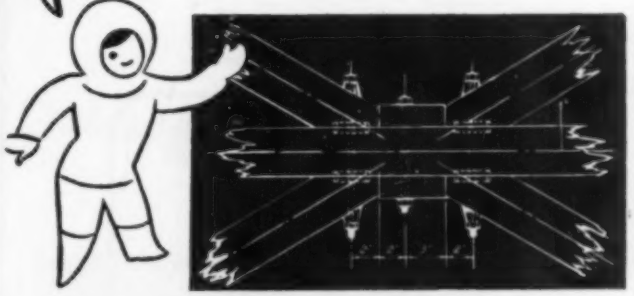
Dept. HPA-10, 417 No. Water St., Milwaukee 2, Wis.

L-H Towers withstand wind pressures up to 150 m.p.h. without guy lines.

ANOTHER **L-H** *Feature*

MAXIMUM STRUCTURAL STRENGTH

1. Teco split-ring timber connectors used at all stress joints.
2. Bolt-thru bracing connected by sidehill washers (no notching).
3. Unit stresses of U. S. Forest Products Laboratory Handbook incorporated in all L-H designs.
4. Prefabricated of heart Redwood, or Tidewater Red Cypress.



L-H FEATURES: • Low pumping and power cost . . . open-flume and gravity-type distribution. • Maintenance-free reduction gear and drive shaft. • Pre-tested performance based on L-H 48-year installations record.

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COOLING TOWERS, INC.
Manufacturers of All Types of Water Cooling Towers
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PLANTS AT ST. LOUIS, MO., AND PLAINVIEW, TEXAS

TIMING MOTORS

Deliveries Being Made Now-

You want controlled power—consistent power—for time controls and time switches. Power that is measured evenly with every electric impulse, giving utmost accuracy and reliability to the carefully geared machines you build. You get this power with

SYNCHRON

TIMING MOTORS
AND
TIME MACHINES

These power units are built to take it—with oil-impregnated double bearings, brass gears, hardened steel shafts—and a reputation for customer satisfaction that dates a quarter of a century.

SYNCHRON synchronus motors are small—only 2¾" by 1 5/16"—with power to pull 8 oz. direct load continuously at 1 RPM. This time-tested motor powers the SYNCHRON Time Machine, a compact little "timer" with a proved record for sustained accuracy and reliable service under all types of working conditions. For complete details, write

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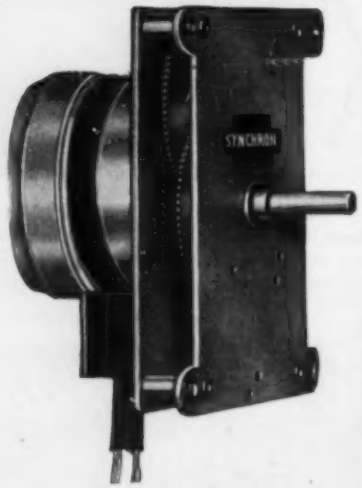

TIME MACHINES

Handling Fluorine

No. 6302—A preliminary 12 page manual (X-1) on the properties and recommended methods of handling fluorine has been published by the Pennsylvania Salt Mfg. Co., 1000 Widener Bldg., Philadelphia. Inasmuch as commercial distribution of bottled fluorine, in limited amounts for research purposes, was announced only last May by this company, the manual is issued in preliminary form to serve an immediate need. It is now being distributed to research laboratories and a small group of industrial firms, universities, and technical libraries. Information is given on storage, withdrawing, piping and fixtures, general precautions, handling leaks, and first aid treatment.

Instruction Manuals

No. 6303—The Ken Cook Co., 710 N. Plankinton Ave., Milwaukee 1, Wis., producers of manuals, parts catalogs, and technical books, has issued a 24 page guide on How to Plan an Owner Manual. The booklet contains suggestions on what to include in a manual of this type and how to present the information in the most effective way. It includes sample pages of sectional and cutaway views, flow diagrams, tune-up and maintenance illustrations, trouble charts, and exploded parts views. The guide is also designed to be used as a reference work book.

Low Temperature Brazing Alloys

No. 6304—A special issue, No. 36, of Low Temperature Brazing News, the house organ of Handy & Harman, 82 Fulton St., New York 7, N. Y., announces two new silver brazing alloys, "Easy-Flo 45" and "Easy-Flo 35." These alloys are offered for joining all fer-

How to STEP UP
air conditioning efficiency

Dorex Air Recovery Units increase plant capacity without increasing conditioning equipment, automatically control odors, and save power and fuel.

A great percentage of the heated, cooled, humidified and cleaned air that is ordinarily exhausted because it is stuffy, odorous or stale can be economically restored to original freshness and recirculated. This reduces the load on heating, refrigerating and humidifying equipment, lowers operating cost and expands the capacity of the system.

Nothing is added to the air. The specially processed activated carbon used in Dorex Air Recovery Equipment extracts all odorous impurities that originate from people and their habits, from tobacco smoke, food and liquor, oils and solvents. Obviously, when you remove these impurities from the indoor air, less outdoor ventilation air is needed, which materially reduces the conditioning load.

PROOF: We will be glad to send the details of typical installations or estimate on planned or existing systems. Write Dept. D5 or call our District Representative.

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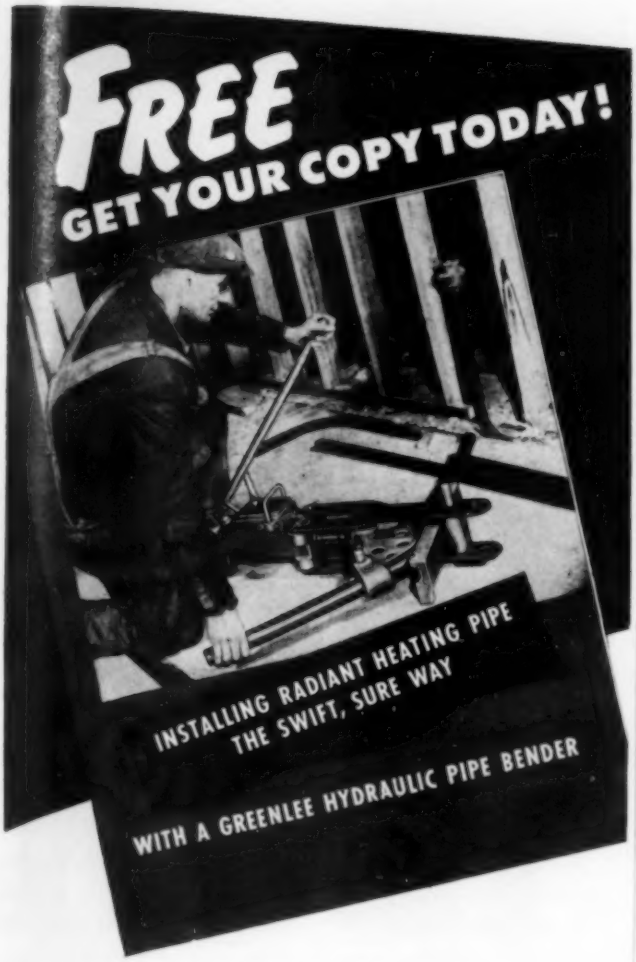


INFORMATIVE CASE STUDY OF RADIANT HEATING PIPE INSTALLATION

• The Radiant Heating Era is here! And whether you are planning radiant heating installations now or are getting set to make them during the big building days at hand, you will want to see this new, pictorial Case Study of a recent radiant heating job.

Contains installation details and illustrations. Shows how important timesavings can be made by using efficient pipe bending methods. Gives data on the GREENLEE Hydraulic Pipe Bender which is designed specifically to speed and perfect radiant heating installations.

Write today for your copy. Ask for folder S-121. Greenlee Tool Co., Division of Greenlee Bros. & Co., 2350 Twelfth Street, Rockford, Illinois, U. S. A.

80th Anniversary
GREENLEE
MACHINERY AND TOOLS

REGISTERED TOOLS
GREENLEE
FOR THE CRAFTSMAN

Are you looking for an air conditioning pump?

Here's what JABSCO has to offer!!

Jabsco – the pump with the rubber impeller – offers many practical, profitable advantages to evaporative type air conditioning applications. *It saves an electric motor* because it connects to the same shaft that drives the blower and operates ideally at blower shaft speeds! *It simplifies installation* because it requires no separate motor or wiring, mounts at any angle, and operates in either direction. *It eliminates service problems* because it is constructed of high-grade bronze with only one moving part – a tough, flexible synthetic rubber impeller. Field tested for more than five years, Jabsco Pumps are still in operation, many using the original impeller. *It is instant self-priming, water lubricated, gearless, and noiseless.* Operates at speeds from 200 to 700 r.p.m. and higher. Put Jabsco in *your* air conditioning plans. Write today for complete details. JABSCO PUMP CO., 8306 Wilshire Blvd., Beverly Hills, Calif.

This simple design is your assurance of dependable operation.

JABSCO

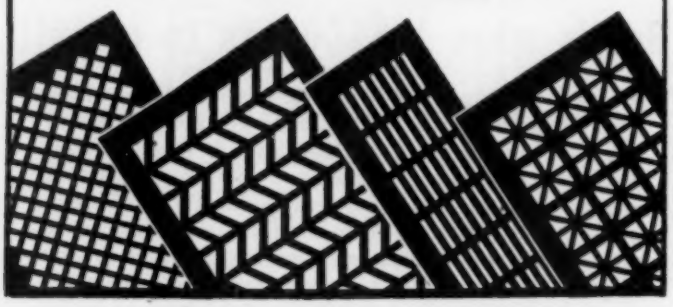
THE PUMP WITH THE RUBBER IMPELLER

AUER REGISTERS and GRILLES

Shown above are Auer "7000" Airo-Flex adjustable-fin type wall register, and also the DuraBilt cross-bar, interlocked construction, floor register. Below are shown a few typical Auer stamped metal grilles. Auer offers dealers and contractors a most complete line of registers and intakes for modern warm air and for air conditioned systems, and grilles for all purposes. Featuring adjustable and air directional models, as well as new style gravity types—Auer can supply ALL your register needs economically. Auer Registers are stocked by leading jobbers. Write for complete Auer Register Book—or Grille Catalog "G".

THE AUER REGISTER COMPANY

3608 Payne Ave. Cleveland 14, Ohio



rous, non-ferrous, and dissimilar metals that melt at temperatures above the working temperature of the alloys. They are said to be extemely fluid at working temperatures and to penetrate rapidly. Properties and advantages are included in the four page folder.

Low Temperature Insulation

No. 6305—The use of asphalt to reduce air infiltration in connection with low temperature insulation, a pictorial discussion of applying cork insulation to a large bolted bonnet gate valve, and construction details of a cold storage fur vault are some of the topics covered in the Vol. 16, No. 3 issue of the house organ published by Armstrong Cork Co., Building Materials Div., Lancaster, Pa.

Magnesia Insulation

No. 6306—The first issue of a new publication, MIMA News, has been released by the Magnesia Insulation Manufacturers Association. The purpose of the publication is said to be the establishment of a helpful medium of contact between the users of 85 per cent magnesia insulation and the manufacturers and to bring helpful information about heat insulations to industrial users. The first issue features an article outlining the new program of the association and includes a discussion of the use of this insulation in war industries and in war shipping. Illustrations of several industrial applications of this insulating material are included.

Packaged Reverse Cycle Air Conditioning Unit

No. 6307—A packaged, reverse cycle air conditioning unit, the "Airtopia," designed for heating, cooling, humidifying, dehumidifying, filtering, and circulating

QUALITY Always! MARTOCELLO Products are fully DEPENDABLE

ATOMIZING SPRAY NOZZLES, SPRAY POND NOZZLES, and CONDENSER WATER DISTRIBUTORS

For Vertical Shell and Tube Ammonia Condensers

ALL MARTOCELLO SPRAY NOZZLES are manufactured with precision and of a design which has been thoroughly tested for maximum results and durability. They are guaranteed to give satisfaction. Successful, efficient results depend largely upon selecting the proper number, type and size of Nozzles suitable for your installation.

THE MARTOCELLO CONDENSER WATER DISTRIBUTORS are now used as standard equipment by Progressive Refrigerating Engineers in solving their Manpower problem, because they require no attention and assure users of the lowest Condenser Operating Pressures and Minimum Power Cost.

It will pay you to consult us. WRITE or WIRE for further information.

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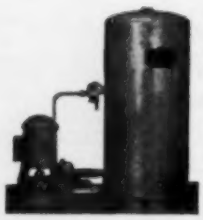

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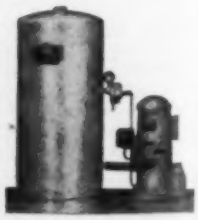

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For Deep or Shallow Wells. Capacities: 400 to 5,000 gals. per hour. Fully Automatic.

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For Shallow Wells. Capacities: 275 to 840 gals. per hour. Uses an unique pumping principle.

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The "Seal of Quality", shown above, is the yardstick of economy in buying galvanized sheets. It signifies at least 2 oz. of Zinc per square foot!

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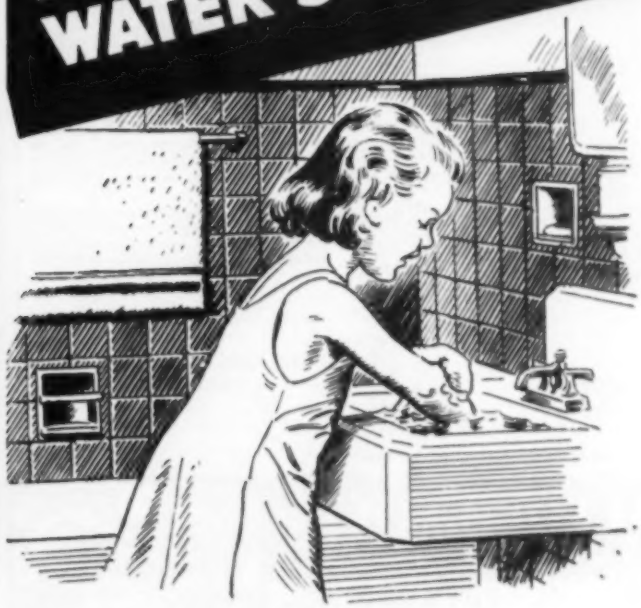

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Then you'll have all these important advantages

- Complete line of Deep Well Systems—both turbine and vertical centrifugal types. Lift water 210 feet.
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- 100% backing by the company.

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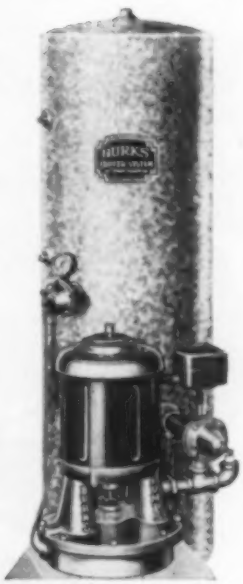

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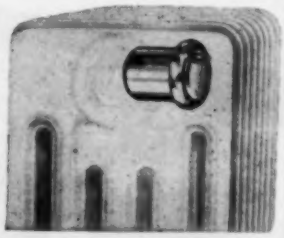

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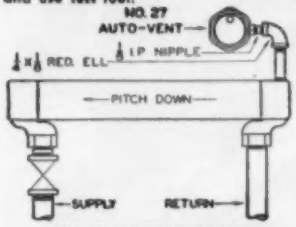
Install the No. 27 Auto-Vent Air Eliminator on all radiators and convectors and release that invisible Air Brake that retards circulation. As air accumulates in the radiators or pipe lines it is automatically vented, assuring perfect circulation throughout the system at all times. You get more even heat and use less fuel.



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No. 27 can be installed on convectors, baseboard radiation panels, radiant heating coils, etc., without the use of an air chamber. For pressures up to 50 lbs.

Ask your jobber—
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MAID-O-MIST INC.

AUTOMATIC HUMIDIFIERS
ALL TYPES OF HEATING SYSTEMS

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air in homes, offices, shops, etc., is described in a new folder and in two data sheets issued by Drayer-Hanson, Inc., 767 E. Pico Blvd., Los Angeles 21, Calif. Units are available in both 3 hp and 5 hp sizes and operate as air cooled compressor-condenser units on the cooling cycle. On the heating cycle outside air is used as the heat source.

Packaged Unit Air Conditioner

No. 6308—A new 12 page booklet provides an introduction to the recently formed Pacific Mfg. Corp., 5308 Blanche Ave., Cleveland, Ohio. Photographs of management executives together with a brief outline of their backgrounds and experiences are featured. The company's manufacturing and research facilities are described and illustrated and the small, room-size packaged air conditioning unit is illustrated.

Pipe and Fitting Materials Chart

No. 6309—Tube Turns, Inc., 224 E. Broadway, Louisville 1, Ky., has prepared a 9 x 14 in. chart which folds to 8½ x 11 in. on pipe and fitting materials. Carbon, intermediate alloy, stainless, and special analysis steels are covered and ASTM specifications, chemical analyses, service temperature limits, and welding data are given. The range of available sizes for welding fittings and forged steel flanges is also tabulated.

Portable Irrigation System

No. 6310—A portable irrigation system utilizing piping, fittings, sprinkler heads, dead end closing pieces, and patented quick couplings is described and illustrated in a new six page bulletin released by the

Air Conditioning HEAT EXCHANGERS

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Conseco 15 Ton freon heat exchanger, Strand Theatre, N. Y.

We design and manufacture heat exchangers for Freon and other refrigerants for refrigeration and air conditioning services. Quick deliveries, Materials available. We recently designed and built eight large Freon condensers in five days. On an urgent West Coast order we designed and built a unit in three days. Two units were built over a weekend for an emergency. Standard units in stock. For quick, economical service, write, wire or phone.

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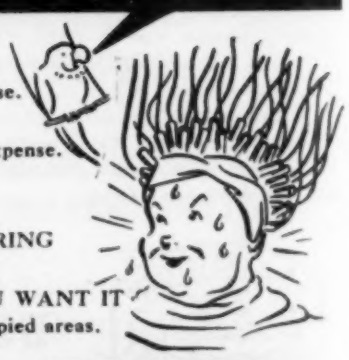
"Yes. *Heat where you want it*—"



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   Saves cleaning expense.
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   Saves heating unoccupied areas.

Propeller fan and blower types.

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Gas unit heaters

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Propeller fan and blower types. Nine sizes of each

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• **SOL-VET "08"** is a fast, efficient cleaner of all equipment using water for cooling. By dissolving impurities *completely* they are carried out *in solution*, and clogging is eliminated. Head pressures fall to normal; heat transfer is raised to maximum; full circulation is restored; life of equipment prolonged. On large jobs, shutdown time is cut to a maximum of 6 to 8 hours.

GUARANTEED EFFECTIVE If you find SOL-VET "08" is not exactly as represented, when used according to instructions and full, accurate report is given within 30 days from date of purchase, your money will be *refunded in full.*

GUARANTEED HARMLESS when used as directed to all water conducting materials used in water cooled equipment.

WRITE TODAY for complete data and analysis and recommendations for your specific problems.

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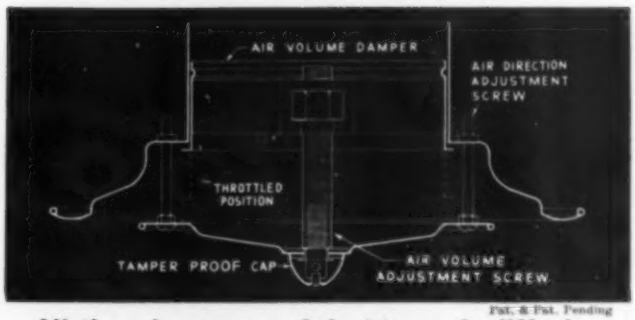

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Volume Damper for fast system balancing regulates the air outlet aperture uniformly without affecting the outlet velocity or diffusion pattern.

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Send for FREE handbook containing sketches, charts, dimension prints and instructive text that simplify the selection and installation of air diffusers. For your copy, please write Dept. D3 using your company letterhead.

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GEHL STOKERS

In Gehl Stokers you get engineering that has met the test over a period of many years . . . stokers built to do a better job for more years, by a 79-year-old company. You get friendly, experienced cooperation based on a long-time knowledge of stoker merchandising.

Among the many features that make Gehl Stokers outstanding are: Heavy, all-cast, rust-resisting chassis . . . Barometric automatic control of chimney draft . . . Unit air and coal feed tube that insures even distribution of air in the fire bed . . . An auto-type transmission . . . A retort that assures efficient combustion.

Domestic and Industrial models now available.

WRITE today for literature and details of the Gehl dealer program.

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A RESPECTED NAME IN AIR CONDITIONING

3 and 5 TON SELF-CONTAINED UNITS

All-purpose, handsomely designed, smooth functioning air conditioning units with all copper condenser and liberally designed coils—removable outlet box for use with duct system—removable panel in back of outlet box for additional grills where front and back air distribution is desired in center of room . . . two way adjustable deflecting grill . . . knock-out for fresh air connection . . . removable one-piece panel in front for easy accessibility. The cabinets are made of furniture steel . . . crackle finish. **Also available with one or two row heating coil.**

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CLEANS AIR FILTERS IN 15 MINUTES!
STOPS FIRE HAZARD—NO ODOR
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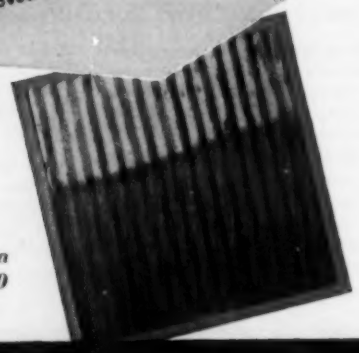
With Turco's new method of cleaning air filters, no special equipment or skilled help is needed. A solution of Turco Aktiv is used in a cold tank. The loosened dirt and grease are easily flushed away with cold water hosing. Filter is dried in stream of air. The Turco Aktiv method has been tested and approved by leading air filter manufacturer.



For complete data Write Dept. HPA-10

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TURCO PRODUCTS, INC. - Main Office and Factory: 6135 S. Central Ave., Los Angeles 1 - Offices and Factories: 1606 Henderson St., Houston 10, Tex. - 175 W. 46th St., Chicago 9 - Offices and Warehouses: All Principal Cities

McDowell Mfg. Co., Pittsburgh 9, Pa. The coupling is of the pressure lock type wherein fluid pressure drives a rubber sealing ring against a coil ring in the unit.

Radiant Heating Controls

No. 6311—A 20 page booklet on how to control radiant heating systems has again been issued by the Johnson Service Co., 507 E. Michigan St., Milwaukee 2, Wis. This new issue is the third edition and it also describes types of radiant systems and various recommended control combinations. In addition to the diagrams of control systems which were previously included in the booklet, the new edition contains a diagram of a zoned radiant heating system with forced ventilation in which room thermostats control unit ventilators in each room and a "Duo-Stat" for each zone controls three-way mixing valves on the water supply line to the coils.

Room Conditioning Units

No. 6312—Two new window type room air conditioning units and a console cabinet unit are covered in a folder issued by the York Corp., York, Pa. These units are designed to cool, dehumidify, filter, and circulate air, as well as introduce fresh air to the room. Window units are available in ½ and ¾ hp sizes and the console unit is offered in the ¾ hp size.

Squirrel Cage Induction Motor

No. 6313—Bulletin No. 720, released by the Louis Allis Co., Milwaukee 7, Wis., covers the company's type OG (protected type) squirrel cage induction motor. Features of the motors, which are designed to provide protection against falling particles and dripping liquids, are described and illustrated. Also

RADIANT HEAT PIPE BENDING is EASY, FAST with "American" MACHINES

Hand powered, the A-30 bends ⅛ to 2" standard pipe sizes at a radius of 5 to 1, up to 180°. Special radii can be supplied within these sizes.

Extra fast! — average bend made in 60 seconds! Versatile! — bends cold pipe, conduit and tube, copper and brass I.P.S. without crimping. Our world-wide customers include the United States Government, 9 foreign governments, and over 12,000 of the world's largest industrial plants.

Among these are:

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CLEAN Chemically ALL HEATING SYSTEMS

We clean and restore to original operating efficiency CHEMICALLY such equipment as:—CONDENSERS — STEAM FEED LINES — CONDENSATE RETURNS — WATER HEATERS — STEAM KETTLES — COOLING AND HEATING COILS — PREHEATERS — HEAT EXCHANGERS — EVAPORATORS — TRAPS OF ALL KINDS — ETC.

We offer RID-AL Service, a highly skilled maintenance service to eliminate sludge and foreign matter from your entire plant SAFELY and economically. No job is too difficult.

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RID-AL Service actually saves your dollars, because your FUEL DOLLARS saved quickly pay for our service.

GET OUR CONSULTATION SERVICE. — WITHOUT OBLIGATION.
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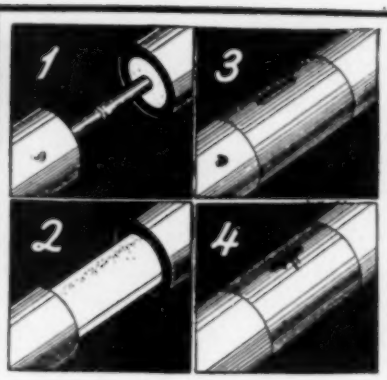
For all your underground and exposed piping jobs you'll like DURANT Pre-Sealed Insulated Pipe. It is waterproof . . . reduces installation costs to a minimum . . . eliminates electrolysis and corrosion . . . requires very little trenching and field work . . . avoids extra cost of waste and breakage . . . comes to you ready to install. In short, D.I.P. is the *perfect pipe* for this type of job. Investgate D.I.P.! Write for details today.



4 Simple Steps

1. Field joint ready for inspection. 2. Joint covered with standard pipe insulation. 3. Durant joint casing in place ready for asphalt. 4. Asphalt poured in slot making a perfect seal.

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The ORIGINAL Pre-sealed Insulated Pipe

BLOWER-TYPE
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UNIT HEATERS

For abundant heat in plants, offices . . . or isolated locations

Economical space heaters for permanent or temporary heating where portable and easily mounted Heaters are needed. Simple operation; air is drawn from back, forced across CHROMALOX Koilstrips by motor-driven fan and directed into desired areas by adjustable louvers. 1.5-KW to 4-KW, 115-V or 230-V.

Investigate this clean, dependable, trouble-free heat. For details, request Catalog 42 and "100 Ways to Apply Electric Heat" booklet.

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ELECTRIC HEAT FOR MODERN INDUSTRY

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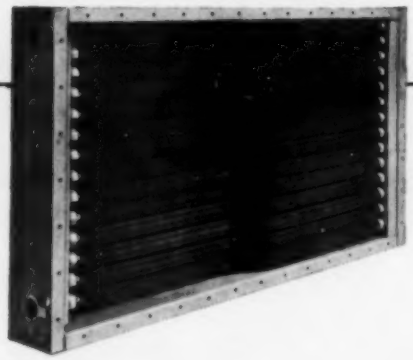

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FOR HEATING AND COOLING IN A WIDE RANGE OF SIZES

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THE G & O MANUFACTURING COMPANY
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Another Great PUMP "by Aurora"
WINS RESPECT THROUGH PERFORMANCE

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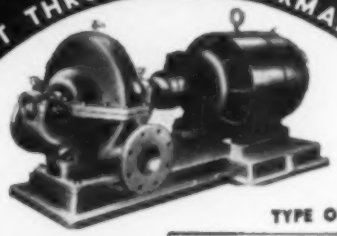
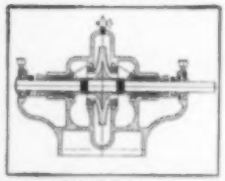


TYPE OD

AURORA CENTRIFUGALS
for Every Pumping Job
HORIZONTAL SPLIT CASE
Single & Two Stage
SIDE SUCTION
VERTICAL
NON CLOG
SUMP
MIXED FLOW
SPECIAL DESIGN
Write for
CONDENSED CATALOG "M"
or
Consult SWEETS

AURORA HORIZONTALLY SPLIT CASE DOUBLE SUCTION SINGLE STAGE CENTRIFUGAL PUMPS



Available in capacities to 4,000 G.P.M. and heads to 300 ft., these accessible, compact, and lasting Type OD Pumps are widely used for general water supply, for municipalities, industrial plants, office buildings, institutions. Also for handling condenser circulating water, wash water, liquids in paper mills and distilleries, chemical solutions, oil in oil fields and refineries, irrigation, etc.

APCO TURBINE-TYPE PUMPS

Here's the Pump for "1001" duties. SIMPLE — only one moving part, the Impeller. Unsurpassed for low capacity, high head duties. Slight change in capacity against drastic head variations.

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BETTER PIPE TOOLS
All "ARMSTRONG BROS." Pipe Cutters, "Barnes Type", "Saunders Type" and "Drop Forged" are improved tools. Pins and rollers are hardened tool steel; will hold their alignment and cut pipe off squarely. They have thin knife blade cutter wheels of alloy steel that cut easily, leave minimum burr, and hold their keen edge.
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1275 Mission St., San Francisco 3, Calif.

pictured are some of the many applications of this type motor. These include machine tools, pressure blowers, pumps, and compressors.

Steam Cleaner

No. 6314—A two page specification circular describing the new model JO Hypressure Jenny Instantaneous Steam Cleaner has been issued by the Homestead Valve Mfg. Co., Coraopolis, Pa. The unit is offered for all types of industrial cleaning applications and utilizes an atomized mixture of steam, hot water, and cleaning compound applied under pressure through a spray nozzle. Normal operating pressures range from 80 to 120 psi at 90 gph water capacity. Oil and gas fired units are optional.

Vertical Mounted Centrifugal Pump

No. 6315—Economy Pumps, Inc., 1000 Weller Ave., Hamilton, Ohio, has issued a new bulletin (No. D-246) illustrating and describing the company's line of SCV pumps. These units are said to provide many advantages over small double suction, horizontal side suction, and close coupled pumps. They are recommended for applications such as brine, cold and hot water circulation, sprinkler systems, pressure boosting, air conditioning systems, and boiler feeding. Dimensions and selection tables are included.

Photograph on page 75 courtesy of the St. Louis Post-Dispatch.

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TUBE EXPANDERS
..experience designed for tough jobs!
Complete literature on Dudgeon products — expanders, hydraulic pumps and jacks — Write to Department L.
The fact that DUDGEON products embody a skillful blend of laboratory and "on-the-job" research is an important factor in their superiority. Combine this engineering policy with new methods and rigid quality control at every stage of production and you have these important reasons for DUDGEON'S century-old leadership in providing better tube expanders, in more diversified types—at lower cost.
DUDGEON TYPE 42
Arranged with tapered rolls for parallel expansion and adjustable for thickness of tube sheet. The adjustable collar bearing on the tube ends is made compact for closely spaced tubes.
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UNIT HEATERS
will last as long as the pipes furnishing steam to them—
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It's the material that makes the difference. GRID HIGH Test Cast Iron Unit Heaters will withstand corrosive atmospheres, and operate efficiently under all atmospheric conditions without maintenance. In many plants GRID installations have been operating continuously for 16 years without maintenance cost. Install unit heaters that will last as long as the pipes furnishing steam to them.
★ One piece construction heating sections (patented) of high test cast iron that withstand steam pressures up to 250 lbs.
★ No soldered, brazed, welded or expanded connections to become loose or develop leaks.
★ No electrolysis to cause corrosion, breakdowns, leaks or heating failures.
SEND for booklet "Corrosion in Unit Heaters"—free upon request.
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